

SEQUENCE LISTING

SEQ ID NO: 1 amino acid sequence comprising GAS 40

MDLEQTKPNQVKQKIALTSTIALLSASVGVSHQVKADDRASGETKASNTHDDSLPKPETIQEAKATIDAVE
KTLSSQQAELTELATALTKTTAEINHLKEQQDNEQKALTSAQEIYTNLTLASSEETLLAQGAHQRELTATE
TELHNAQADQHSKETALSEQKASISAETTRAQDLVEQVKTSEQNIAKLNAMISNPDAITKAAQTANDNTKA
LSSELEKAKADLENQKAKVKKQLTEELAAQKAALAEKEAELSRKSSAPSTQDSIVGNNTMKAPQGYPLEE
LKKLEASGYIGSASYNYYKEHADQIIAKASPGNQLNQYQDIPADRNRFPVDPDNLTPEVQNELAQFAAHMI
NSVRRQLGLPPVTVTAGSQEFARLLSTSYKKTHGNTRPSFVYGQPGVSGHYGVGPHDKTIIEDSAGASGLI
RNDNMYENIGAFNDVHTVNGIKRGIYDSIKYMLFTDHLHGNTYGHAINFLRVDKHNPNAPVYLGFSTSNV
GSLNEHFVMFPESNIAHQRFNKTPIKAVGSTKDYAQRVGTVSDTIAAIKGVSSLENRLSAIHQEADIMA
AQAKVSQLOQGLASTLKQSDSLNLQVRQLNDTKGSLRTELLAAKAKQAQLEATRDQSLAKLASLKAALHQT
EALAEQAAARVTALVAKKAHLQYLRDFKLNPNRLQVIRERIDNTKQDLAKTTSSLLNAQEALALQAKQSS
LEATIATTEHQLTLLKTLANEKEYRHLDEDIATVPDLQVAPPLTGVKPLSYSKIDTTPLVQEMVKETKQLL
EASARLAAENTSLVAEALVGQTSEMVASNAIVSKITSSITQPSSKTSYSGSGSSTTSNLI SDVDESTQRALK
AGVVMLAAVGLTGFRFRKESK

SEQ ID NO: 2 polynucleotide sequence encoding for GAS 40

ATGGACTTAGAACAAACGAAGCCAAACCAAGTTAAGCAGAAAATTGCTTTAACCTCAACAATTGCTTTATT
GAGTGCCAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTA
ATACTCACGACGATAGTTTACCAAACAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAA
AAAACCTCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAACTACTGCTGAAAT
CAACCACTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATA
CTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAA
ACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGAGCTGCATTGTCAGAACAAAAAGCTAGCAT
TTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAAACGTCTGAACAAAATATTGCTAAGC
TCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCA
TTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAAAAGCAATTGAC
TGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTCAG
CTCCGTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTATCCTCTTGAAGAA
CTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGA
TCAAATTTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCCAGCAGATCGTAATC
GCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATT
AATAGTGTAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATT
ACTTAGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTAT
CAGGGCATTTATGGTGTGGGCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCAT
CGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACTGTGAATGGTATTAAACG
TGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTA
TTAACTTTTTACGTGTAGATAAACATAACCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATGTA
GGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGAC
CCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGCAG
CGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGGCTATTCATCAAGAAGCTGATATTATGGCA
GCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCT
CCAAGTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACAAG
CACAACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACA
GAAGCCTTAGCAGAGCAAGCCGCAGCCAGAGTGACAGCACTGGTGGCTAAAAAAGCTCATTTGCAATATCT
AAGGGACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATT
TGGCTAAAACCTACCTCATCTTTGTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGT
CTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAACCTTAGCTAACGAAAAGGAATA
TCGCCACTTAGACGAAGATATAGCTACTGTGCTGATTGCAAGTAGCTCCACCTCTTACGGGCGTAAAC
CGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAATGGTTAAAGAAACGAAACAACCTATTA
GAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGA
AATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTT
ATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAAAGAGCTCTTAA
GCAGGAGTCGTCATGTTGGCAGCTGTGCGCCTCACAGGATTTAGGTTCCGTAAGGAATCTAAGTGA

SEQ ID NO: 3 amino acid sequence comprising an N terminal leader sequence of GAS 40

MDLEQTKPNQVKQKIALTSTIALLSA

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SEQ ID NO: 4 polynucleotide sequence encoding an N terminal leader sequence of GAS 40
ATGGACTTAGAACAAACGAAGCCAAACCAAGTTAAGCAGAAAATTGCTTTAACCTCAACAATTGCTTTATT
GAGTGCC

SEQ ID NO: 5 amino acid sequence comprising a fragment of GAS 40 with N terminal leader
sequence removed

SVGVSHQVKADDRASGETKASNTHDDSLPKPETIQEAKATIDAVEKTL SQQKAELTELATALTKTTAEINH
LKEQQDNEQKAL TSAQEIYTNTLASSEETLLAQGAHQRELTATETELHNAQADQHSKETALSEQKASISA
ETTRAQDLVEQVKTSEQNIAKLNAMISNPDAITKAAQTANDNTKALSSELEKAKADLENQKAKVKKQLTEE
LAAQKAALAEKEAELSRLKSSAPSTQDSIVGNNTMKAPQGYPLEELKKLEASGYIGSASYNYYKEHADQI
IAKASPGNQLNQYQDIPADRNRFVDPDNLTPEVQNELAQFAAHMINSVRRQLGLPPVTVTAGSQEFARLLS
TSYKKTHGNTRPSFVYGQPGVSGHYGVGPHDKTIIEDSAGASGLIRNDDNMYENIGAFNDVHTVNGIKRGI
YDSIKYMLFTDHLHGNTYGHAINFLRVDKHNPNAPVYLGFSTSNVGSLSNEHFVMFPESNIANHQRFNKTPI
KAVGSTKDYAQRVGTVSDTIAAIKGVSSLENRLSAIHQEADIMAAQAKVSQLOGKLASTLKQSDSLNLQV
RQLNDTKGSLRTELLAAKAKQAQLEATRDQSLAKLASLKAALHQTEALAEQAAARVTALVAKKAHLQYL RD
FKLNP NRLQVIRERIDNTKQDLAKTTSSLLNAQEALALQAKQSSLEATIATTEHQLTLLKTLANEKEYRH
LDEDIATVPDLQVAPPLTGVPKLSYSKIDTTPLVQEMVKETKOLLEASARLAAENTSLVAEALVGQTSEMV
ASNAIVSKITSSITQPSSKTSYSGSGSSTTSNLSVDDESTQRALKAGVVMLAAVGLTGFRFRKESK

SEQ ID NO: 6 polynucleotide sequence encoding a fragment of GAS 40 with N terminal leader
sequence removed

AGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATACTCA
CGACGATAGTTTACCAAACAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAAATC
TCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAACTACTGCTGAAATCAACCAC
TTAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCTTGC
AAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAGAGC
TTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTCAGAACAAAAAGCTAGCATTTCAGCA
GAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGTCTGAACAAAATATTGCTAAGCTCAATGC
TATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTAAGCT
CAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAAAAAGCAATTGACTGAAGAG
TTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTCAGCTCCGCTC
TACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTATCCTCTTGAAGAACTTAAAA
AATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGATCAAATT
ATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCAGCAGATCGTAATCGCTTTGT
TGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATAGTG
TAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATTACTTAGT
ACCAGCTATAAGAAAACTCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTATCAGGGCA
TTATGGTGTGTTGGGCCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATTCGAAATG
ATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACTGTGAATGGTATTAAACGTGGTATT
TATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTATTAACCTT
TTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGATCTT
TGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGACCCCTATA
AAAGCCGTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACCTGTATCTGATACTATTGCAGCGATCAA
AGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTTCATCAAGAAGCTGATATTATGGCAGCCCAAG
CTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAAGTG
AGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACAAGCACAAC
CGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACAGAAGCCT
TAGCAGAGCAAGCCGACGACAGAGTGACAGCACTGGTGGCTAAAAAAGCTCATTGTGCAATATCTAAGGGAC
TTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATTGGCTAA
AACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGTCTAGAAG
CTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAAACCTTAGCTAACGAAAAGGAATATCGCCAC
TTAGACGAAGATATAGCTACTGTGCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAACCGCTATC
ATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAGAAACGAAACAACCTATTAGAAGCTT
CAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTTGGCCAAACCTCTGAAATGGTA
GCAAGTAATGCCATTGTGTCTAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTTATGGCTC

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AGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAAAGAGCTCTTAAAGCAGGAG
TCGTCATGTTGGCAGCTGTCGGCCTCACAGGATTTAGGTTCCGTAAGGAATCTAAGTGA

SEQ ID NO: 7 amino acid sequence comprising a C terminal transmembrane region of GAS 40
ALKAGVVMLAAVGLTGFRFRKESK

SEQ ID NO: 8 polynucleotide sequence encoding a C terminal transmembrane region of GAS 40
GCTCTTAAAGCAGGAGTCGTCATGTTGGCAGCTGTCGGCCTCACAGGATTTAGGTTCCGTAAGGAATCTAA
GTGA

SEQ ID NO: 9 amino acid sequence comprising a fragment of GAS 40 with a C terminal
transmembrane sequence removed

MDLEQTKPNQVKQKIALTSTIALLSASVGVSHQVKADDRASGETKASNTHDDSLPKPETIQEAKATIDAVE
KTLSQQKAELTELATALTKTTAEINHLKEQQDNEQKAL TSAQEITYNTLASSEETLLAQGAEHQRELTATE
TELHNAQADQHSKETALSEQKASISAETTRAQDLVEQVKTSEQNIAKLNAMISNPDAITKAAQTANDNTKA
LSSELEKAKADLENQKAKVKKQLTEELAAQKAALAEKEAELSRLKSSAPSTQDSIVGNNTMKAPQGYPLEE
LKKLEASGYIGSASYNYYKEHADQIIAKASPGNQLNQYQDIPADRNRFDVDPDNLTPEVQNELAQFAAHMI
NSVRRQLGLPPVTVTAGSQEFARLLSTSYKKTHGNTRPSFVYGQPGVSGHYGVGPHDKTI IEDSAGASGLI
RNDNMYENIGAFNDVHTVNGIKRGIYDSIKYMLFTDHLHGNTYGHAINFLRVDKHNPNAPVYLGFSTSNV
GSLNEHFVMFPESNIAHQRFNKTPIKAVGSTKDYAQRVGTVDITAAIKGKVSSLENRLSAIHQEADIMA
AQAKVSQQLQGLASTLQSDSLNLQVRQLNDTKGSLRTELLAAKAKQAQLEATRDQSLAKLASLKAALHQT
EALAEQAAARVTALVAKKAHLQYLRDFKLNPNRLQVIRERIDNTKQDLAKTTSSLLNAQEALALQAKQSS
LEATIATTEHQLTLLKTLANEKEYRHLDEDIATVPDLQVAPPLTGVKPLSYSKIDTTPLVQEMVKETKQLL
EASARLAAENTSLVAEALVGQTSEMVASNAIVSKITSSITQPSSKTSYSGSGSSTTSNLI SDVDESTQR

SEQ ID NO: 10 polynucleotide sequence encoding a fragment of GAS 40 with a C terminal
transmembrane sequence removed

ATGGACTTAGAACAAACGAAGCCAAACCAAGTTAAGCAGAAAATTGCTTTAACCTCAACAATTGCTTTATT
GAGTGCCAGTG TAGGCGTATCTACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTA
ATACTCACGACGATAGTTTACCAAAACCAGAAACAATTCAAGAGGCCAAAGGCAACTATTGATGCAGTTGAA
AAAACCTCTCAGTCAACAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAACCTACTGCTGAAAT
CAACCACTTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATA
CTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAA
ACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTGTCAGAACAAAAGCTAGCAT
TTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGCTCTGAACAAAATATTGCTAAGC
TCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCA
TTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAAAAGCAATTGAC
TGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTCAG
CTCCGTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTATCCTCTTGAAGAA
CTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGA
TCAAATTTATGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCCAGCAGATCGTAATC
GCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATT
AATAGTGTAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATT
ACTTAGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTAT
CAGGGCATTATGGTGTGGGCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATT
CGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACTGTGAATGGTATTAAACG
TGGTATTTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTA
TTAACTTTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATGTA
GGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGAC
CCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGCAG
CGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTCATCAAGAAGCTGATATTATGGCA
GCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCT
CCAAGTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACAAG
CACAACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACA
GAAGCCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACTGGTGGCTAAAAAAGCTCATTGCAATATCT
AAGGGACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATT

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TGGCTAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGT
CTAGAAGCTACTATTGCTACCCACAGAACACCAGTTGACTTTGCTTAAACCTTAGCTAACGAAAAGGAATA
TCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAAC
CGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAGAAACGAAACAACCTATTA
GAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTTAGCAGAAGCGCTTGTTGGCCAAACCTCTGA
AATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTT
ATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAAAGA

SEQ ID NO: 11 amino acid sequence comprising a transmembrane region of GAS 40 as shown in Figures 1 and 2. ALKAGVVMLAAVGLTG

SEQ ID NO: 12 amino acid sequence comprising a first coiled-coil region of GAS 40
ETIQEAKATIDAVEKTLSSQKAELTELATALTKTTAEINHLKEQQDNEQKALTSAQEIYTNLTASSEETLL
AQGAHQRELTATETELHNAQADQHSKETALSEQKASISAETTRAQDLVEQVKTSEQNIAKLNAMISNPDA
ITKAAQTANDNTKALSSELEKAKADLENQKAKVKKQLTEELAAQKAALAEKEAELSRLKSSA

SEQ ID NO: 13 amino acid sequence comprising a second coiled-coil region of GAS 40
RLSAIHQEADIMAAQAKVSQLOGLASTLKQSDSLNLQVRQLNDTKGSLRTELLAAKAKQAQLEATRDQSL
AKLASLKAALHQTEALAEQAARVTALVAKKAHLQYLRDFKLNPNRLQVIRERIDNTKQDLAKTTSSLLNA
QEALALQAKQSSLEATIATTEHQLTLLKTLANEKE

SEQ ID NO: 14 amino acid sequence comprising a leucine zipper motif within the second coiled-coil region of GAS 40.
QVIRERIDNTKQDLAKTTSSLLNAQEALAL

SEQ ID NO: 15 amino acid sequence comprising SpA from *Streptococcus gordonii* Genbank reference GI 25990270
MNRKKEVFGFRKSKVAKTLCGAVLGAALIAIADQQVLADDEVTEETNSTANVAVTTTGNPATNLPEAQGEATE
AASQSQAQAGSKEGALPVEVSADDLNQAVTDAKAAGVNVVQDQTSKGTATTAAENAQKQAEIKSDYAKQA
EEIKKTTEAYKKEVEAHQAETDKINAENKAAEDKYQEDLKAHQAEVEKINTANATAKAEYEAKLAQYQKDL
AAVQKANEDSQLDYQNKLSAYQAELARVQKANAEAKEAYEKAVKENTAKNAALQAENEAIKQNETAKANY
DAAMKQYEADLAAIKKAKEDNDADYQAKLAAYQAELARVQKANADAKAAYEKAVEENTAKNTAIQAENEAI
KQRNAAAKATYEAALKQYEADLAAAKKANEDSDADYQAKLAAYQTELARVQKANADAKAAYEKAVEDNKAK
NAALQAENEEIKQRNAAAKT DYEA KLAKYEADLAKYKKELAEYPAKLKAYEDEQAQIKAALVELEKNKNQD
GYLSKPSAQSLSVYDSEPNAQLSLTTNGKMLKASAVDEAFSHDTAQYSSKILQPDNLNVSYLQQADDVTSSM
ELYGNFGDKAGWTTTVGNNTVEVKFASVLLERGQSVTATYTNLEKSYNGKKISKAVFKYSLSDSKFKNVD
KAWLGVLDPPTLGVFASAYTGQEEKDTSIFIKNEFTFYDENDQPINFDNALLSVASLNRENNSIEMAKDYS
GTFVKISGSSVGEKDGKIYATETLNFKQGGSRWTMYKNSQPGSGWDSSDAPNSWYGAGAISMSGPTNHV
TVGAISATQVVPSPVMAVATGKRPNIWYSLNGKIRAVNVPKITKEKPTPPVAPTEPQAPTYEVEKPLEPA
PVAPTYENEPTPPVKTPDQPEPSKPEEPTYETEKPLEPAPVVPTYENEPTPPVKTPDQPEPSKPEEPTYET
EKPLEPAPVAPTYENEPTPPVKTPDQPEPSKPEEPTYDPLPTPPVAPTPKQLPTPPVVPTVHFHYSSLLAQ
PQINKEIKNEDGVDIDRTLVAKQSIVKFELKTEALTAGRPKTTSFVLVDPLPTGYKFDLDATKAASTGFDT
TYDEASHTVTFKATDETLATYNADLT KPVELTHPTVVGRVLNDGATYINNFTLTVNDAYGIKSNVVRVTTP
GKPNDPDPNPNNNYIKPTKVNKNKEGLNIDGKEVLGAGSTNYEELTWDLQYKGDKSSKEAIQNGFYVDDYP
EEALDVRPDLVKVADEKGNQVSGVSVQQYDSLEAAPKKVQDLLKKANITVKGAFQLFSADNP EEFYKQYVS
TGTSLVITDPMTVKSEFGKTGGKYENKAYQIDFGNGYATEVVVNNVPKITPKKDVTVSLDPTSENLDGQTV
QLYQTFNYRLIGGFIPQNHSEELDYSFVDDYDQAGDQYTGNYKTFSSLNLTMKDGSVIKAGTDLTSQTTA
ETDAANGIVTVRSKEDSLQKISLDSFPQAETYLQMRRIAIGTFENTYVNTVNKVAYASNTVVRTTTPIPTP
DKPTPIPTPKPKDPDKPETPKPKVPSPKVEDPSAPIPVSVGKELTTLPKTGTNDSSYMPYLGLAALVGVL
GLGQLKRKEDESN

SEQ ID NO: 16 amino acid sequence comprising Streptococcal surface protein B precursor from *Streptococcus gordonii* Genbank reference GI 25055226 AAC44102.3

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MQKREVFGRKSKVAKTLCGAVLGAALIAIADQQVLADEVTETNSTANVAVTTTGNPATNLPEAQGEATEA
 ASQSQAGAGSKDGALPVEVSADDLNKAVTDAKAAGVNVVQDQTSKGTATTAENAQKQAEIKSDYAKQAE
 EIKKTTEAYKKEVEAHQAETDKINAENKAAEDKYQEDLKAHQAEVEKINTANATAKAIEYAKLAQYQKDLA
 AVQKANEDSQLDYQNKLSAYQAEELARVQKANAEAKEAYEKAVKENTAKNAALQAENEAIKQRNETAKANYD
 AAMKQYEADLAAIKKAKEDNDADYQAKLAAYQAEELARVQKANADAKAAYEKAVEENTAKNTAIQAENEAIK
 QRNETAKATYEAAYKQYEADLAAVQKANATNEADYQAKLAAYQTELARVQKANADAKATYEEKAVEDNKA
 AALQAENEEIKQRNAAAKTDYEAKLAKYEADLAKYKKDFAAYTAALAEAESKKKQDGYLSEPRSQSLNFKS
 EPNAIRTIDSSVHQYGOQELDALVKSWSGISPTNPDRKKSTAYSIFNAINSNNTYAKLVLEKDKPVDVTYTG
 LKNSSFNKGKISKVVYTYTLKETGFDDGKMTMFASSDPTVTAWYNDYFTSTNINVVKFYDEEGQLMNL
 GGLVNFSSLNRRNGSGAIDKDAIESVRNFRNGRYIPISGSSIKIHENNSAYADSSNAEKSRGARWDTSEWDT
 TSSPNNWYGAIVGEITQSEISFNMASSKSGNIWFAFNSNINAIGVPTKPVAPTAPTQPMYETEKPLEPAPV
 VPTYENEPTPPVKTPDQPEPSKPEEPTYETEKPLEPAPVAPTYPENEPTPPVKIPDQPEPSKPEEPTYETEK
 PLEPAPVAPTYPENEPTPPVKTPDQPEPSKPEEPTYDPLPTPLAPTPTKQLPTPPVPTVHFHYSSLLAQPO
 INKEIKNEDGVDIDRTLVAKQSIGKFEKTEALTAGRPKTTSFVLVDPLPTGYKFDLDATKAASSTGFDTTY
 DEASHTVTFKATDETALATYNADLTKEPVETLHPTTVGRVLNDGATYTNFTLTVNDAYGIKSNVVRVTTPGK
 PNDPDNPNNNYIKPTKVNKNKEGLNIDGKEVLGASTNYEELTWDLQYKGDSSKEAIQNGFYVDDYPEE
 ALDVRPDLVKVADEKGNQVSGVSVQQYDSLEAAPKKVQDLLKKANITVKGAFLFSADNPEEFYKQYVSTG
 TSLVITDPMTVKSEFGKTGGKYENKAYQIDFGNGYATEVVNNVPKITPKKDVTVSLDPTSENLDGQTVQL
 YQTFNYRLIGGFIPQNHSELEDYSFVDDYDQAGDQYTGNYKTFSSNLTMKDGSVIKAGTDLTSQTTAET
 DATNGIVTVRFKEDFLQKISLDSPFQAETYLQMRRIAIGTFENTYVNTVNVKAYASNTVTRTTPIRTPDK
 PTPIPTPKPKDPDKPETPKPKVPSPKVEDPSAPIPVSVGKELTTLPKTGTNDATYMPYLGALALVGFLGL
 GLAKRKED

SEQ ID NO: 17 amino acid sequence comprising PspA from *Streptococcus pneumoniae*
 Genbank reference GI 282335

MNKKKMILTSLASVAILGAGFVASQPTVVRAEESPVASQSKAEKDYDAKKDAKNAKKAVERDAQKALDDAK
 AAQKKYDEDQKKTEEKAALAEKAAEEMDKAVAAVQQAYLAYQQATDKAAKDAADKMIDEAKKREEEAKTKF
 NTVRAMVPEPEQLAETKKKSEEAKQKAPELTKKLEEAKEAEKATEAKQKVDAAEEVAPQAKIAELE
 NQVHRLEQELKEIDESESEDYAKEGFRAPLQSKLDAKKAKLSKLEELSDKIDELDAEIAKLEDQLKAAEEN
 NNVEDYFKEGLEKTIAAKKAELEKTEADLKKAVNEPEKPAPAPETPAPEAPAEQPKPAPAPQAPAPKPEK
 PAEQPKPEKTDDQQAEDYARRSEEEYNRLTQQQPPKAEPAPAPKTGWKQENGMYFYNTDGSMATGWLQ
 NNGSWYYLNSNGAMATGWLQYNGSWYYLNANGAMATGWAKVNGSWYYLNANGAMATGWLQYNGSWYYLNAN
 GAMATGWAKVNGSWYYLNANGAMATGWLQYNGSWYYLNANGAMATGWAKVNGSWYYLNANGAMATGWVKDG
 DTWYYLEASGAMKASQWFKVSDKWYVNGLGALAVNTTVDGYKVNANGEWV

SEQ ID NO: 18 amino acid sequence comprising a portion of Se89.9 of *Streptococcus equi*
 Genbank reference GI 2330384

ESDIVDATRFSTTEIPKSGQVIDRSASIQALTNDIASIKGKIASLESRLADPSSEAEVTAQAQAKISQLQH
 QLEAAQAKSHKLDQQVEQLANTKDSLRTQLLAKEEQALKANLDKALALLASSKATLHKLEAAMEEAKA
 RVAGLASQKAQLEDLLAFKPNPNRIELAQEKVAAAKKALADTEDKLLAAQASLSDLQAQRARLQLSIATI

SEQ ID NO: 19 polynucleotide sequence comprising GST-40-HIS

CTGGTTCGCGTGGATCCCATATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGG
 AGAAACGAAGGCGAGTAATACTCACGACGATAGTTTACCAAACAGAAACAATTCAAGAGGCAAAGGCAA
 CTATTGATGCAGTTGAAAAACTCTCAGTCAACAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACA
 AAACTACTGCTGAAATCAACCACTTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACA
 AGAAATTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAG
 AGTTAACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTTCAAAGAGAGCTGCATTGTCA
 GAACAAAAGCTAGCATTTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGCTCTGA
 ACAAAATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTA
 ATGATAATACAAAAGCATTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAA
 GTTAAAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAGAGGCAGAACTTAG
 TCGTCTTAAATCCTCAGCTCCGCTACTCAAGATAGCATTTGTGGGTAATAATACCATGAAAGCACCGCAAG
 GCTATCCTCTTGAAGAACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTAT
 TACAAAGAGCATGCAGATCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATAT
 TCCAGCAGATCGTAATCGCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGT

SEQUENCE LISTING

TTGCAGCTCACATGATTAATAGTGTAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCA
 CAAGAATTTGCAAGATTACTTAGTACCAGCTATAAGAAAACATGGAATACAAGACCATCATTTGTCTA
 CGGACAGCCAGGGGTATCAGGGCATTATGGTGTGGGCCTCATGATAAACTATTATTGAAGACTCTGCCG
 GAGCGTCAGGGCTCATTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACT
 GTGAATGGTATTAAACGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAA
 TACATACGGCCATGCTATTAACCTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGAT
 TTTCAACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCAT
 CAACGCTTTAATAAGACCCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGT
 ATCTGATACTATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTCATCAAG
 AAGCTGATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAG
 TCAGACAGCTTAAATCTCAAGTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGC
 AGCTAAAGCAAAACAAGCACAACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAG
 CCGCACTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACTGGTGGCTAAAAAA
 GCTCATTTGCAATATCTAAGGGACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTTGA
 TAATACTAAGCAAGATTTGGCTAAAACCTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTAC
 AAGCTAAACAAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAACCTTA
 GCTAACGAAAAGGAATATCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACC
 TCTTACGGGCGTAAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAG
 AAACGAAACAACCTATTAGAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTT
 GTTGGCCAAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCC
 CTCATCTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTA
 CTCAAAGAGCTCTTAAAGCAGGAGTCGTCATGTTGGCAGCTGTCGGCCTCACAGGATTTAGGTTCCGTAAG
 GAATCTAAGGCGGCCGCACTCGAGCACCACCACCACCACCACCAC

SEQ ID NO: 20 amino acid sequence comprising GST-40-HIS

L V P R G S H Met S V G V S H Q V K A D D R A S G E T K A S N T H D D S
 L P K P E T I Q E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T
 K T T A E I N H L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E
 T L L A Q G A E H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E
 Q K A S I S A E T T R A Q D L V E Q V K T S E Q N I A K L N A Met I S N
 P D A I T K A A Q T A N D N T K A L S S E L E K A K A D L E N Q K A K V
 K K Q L T E E L A A Q K A A L A E K E A E L S R L K S S A P S T Q D S I
 V G N N T Met K A P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y
 K E H A D Q I I A K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L
 T P E V Q N E L A Q F A A H Met I N S V R R Q L G L P P V T V T A G S Q
 E F A R L L S T S Y K K T H G N T R P S F V Y G Q P G V S G H Y G V G P
 H D K T I I E D S A G A S G L I R N D D N Met Y E N I G A F N D V H T V
 N G I K R G I Y D S I K Y Met L F T D H L H G N T Y G H A I N F L R V D
 K H N P N A P V Y L G F S T S N V G S L N E H F V Met F P E S N I A N H
 Q R F N K T P I K A V G S T K D Y A Q R V G T V S D T I A A I K G K V S
 S L E N R L S A I H Q E A D I Met A A Q A K V S Q L Q G K L A S T L K Q
 S D S L N L Q V R Q L N D T K G S L R T E L L A A K A K Q A Q L E A T R
 D Q S L A K L A S L K A A L H Q T E A L A E Q A A A R V T A L V A K K A
 H L Q Y L R D F K L N P N R L Q V I R E R I D N T K Q D L A K T T S S L
 L N A Q E A L A A L Q A K Q S S L E A T I A T T E H Q L T L L K T L A N
 E K E Y R H L D E D I A T V P D L Q V A P P L T G V K P L S Y S K I D T
 T P L V Q E Met V K E T K Q L L E A S A R L A A E N T S L V A E A L V G
 Q T S E Met V A S N A I V S K I T S S I T Q P S S K T S Y G S G S S T T
 S N L I S D V D E S T Q R A L K A G V V Met L A A V G L T G F R F R K E
 S K A A A L E H H H H H H

SEQ ID NO: 21 polynucleotide sequence comprising 40a-HIS

ATGAGTGTAGGCGTATCTACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATAC
 TCACGACGATAGTTTACCAAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAAA
 CTCTCAGTCAACAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAACCTACTGCTGAAATCAAC
 CACTTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCT

SEQUENCE LISTING

TGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAG
 AGCTTCATAATGCTCAAGCAGATCAACATTTCAAAGAGAGCTGCATTGTCAGAACAAAAAGCTAGCATTTC
 GCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGTCTGAACAAAATATTGCTAAGCTCAA
 TGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTAA
 GCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAAAAAGCAATTGACTGAA
 GAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTCAGCTCC
 GTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTATCCTCTTGAAGAACTTA
 AAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGATCAA
 ATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCCAGCAGATCGTAATCGCTT
 TGTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATA
 GTGTAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATTACTT
 AGTACCAGCTATAAGAAAACATCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTATCAGG
 GCATTATGGTGTGGGCCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATTCGAA
 ATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACTGTGAATGGTATTAAACGTGGT
 ATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTATTAA
 CTTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGAT
 CTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGACCCCT
 ATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGCAGCGAT
 CAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTCATCAAGAAGCTGATATTATGGCAGCCC
 AAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAA
 GTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACAAGCACA
 ACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACAGAAG
 CCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACTGGTGGCTAAAAAAGCTCATTGTGCAATATCTAAGG
 GACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATTTGGC
 TAAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGTCTAG
 AAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAACCTTAGCTAACGAAAAGGAATATCGC
 CACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAACCGCT
 ATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAATGGTTAAAGAAACGAAACAACCTATTAGAAG
 CTTACAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGAAATG
 GTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTTATGG
 CTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAACGtGCGGCCGCACTCG
 AGCACCACCACCACCACCAC

SEQ ID NO: 22 amino acid sequence comprising 40a-HIS

M S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q
 E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H
 L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E
 H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E
 T T R A Q D L V E Q V K T S E Q N I A K L N A Met I S N P D A I T K A A
 Q T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L
 A A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A
 P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A
 K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A
 Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y
 K K T H G N T R P S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A
 G A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S I
 K Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G F
 S T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G S
 T K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E A
 D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T
 K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L
 H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N R
 L Q V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q
 S S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T V
 P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L
 L E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K I

SEQUENCE LISTING

T S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R A A A
L E H H H H H H H

SEQ ID NO: 23 polynucleotide sequence comprising 40a-RR-HIS

ATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATAC
TCACGACGATAGTTTACCAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAAA
CTCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAACTACTGCTGAAATCAAC
CACTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCT
TGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAG
AGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTCAGAACAAAAAGCTAGCATTTC
GCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGCTCTGAACAAAATATTGCTAAGCTCAA
TGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTA
GCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAAAAAGCAATTGACTGAA
GAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTCAGCTCC
GTCTACTCAAGATAGCATTTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTATCCTCTTGAAGAACTTA
AAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGATCAA
ATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCCAGCAGATCGTAATCGCTT
TGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATA
GTGTACGtGtCAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATTACTT
AGTACCAGCTATAAGAAAACTCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTATCAGG
GCATTATGGTGTGTTGGGCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATTCGAA
ATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACTGTGAATGGTATTAAACGTGGT
ATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTATTAA
CTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGATTTTCAACCAGCAATGTAGGAT
CTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGACCCCT
ATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGCAGCGAT
CAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTCATCAAGAAGCTGATATTATGGCAGCCC
AAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAA
GTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACAAGCACA
ACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACAGAAG
CCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACTGGTGGCTAAAAAAGCTCATTGTGCAATATCTAAGG
GACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTTGATAATACTAAGCAAGATTTGGC
TAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGTCTAG
AAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAACCTTAGCTAACGAAAAGGAATATCGC
CACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAACCGCT
ATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAGAAACGAAACAACACTATTAGAAG
CTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGAAATG
GTAGCAAGTAATGCCATTGTGTCTAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTTATGG
CTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAAGtGCGGCCGCACTCG
AGCACCACCACCACCACCACCAC

SEQ ID NO: 24 amino acid sequence comprising 40a-RR-HIS

M S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q
E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H
L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E
H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E
T T R A Q D L V E Q V K T S E Q N I A K L N A Met I S N P D A I T K A A
Q T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L
A A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A
P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A
K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A
Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y
K K T H G N T R P S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A
G A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S I
K Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G F
S T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G S

SEQUENCE LISTING

T K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E A
D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T
K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L
H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N R
L Q V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q
S S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T V
P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L
L E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K I
T S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R A A A
L E H H H H H H H

SEQ ID NO: 25 polynucleotide sequence comprising 40a-RR (nat)

ATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATAC
TCACGACGATAGTTTACCAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAA
CTCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAACTACTGCTGAAATCAAC
CACTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCT
TGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAG
AGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTCAGAACAAAAAGCTAGCATTTCA
GCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGCTCTGAACAAAATATTGCTAAGCTCAA
TGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTA
GCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAAAAAGCAATTGACTGAA
GAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTCAGCTCC
GTCTACTCAAGATAGCATTTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTATCCTCTTGAAGAAGTTA
AAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGATCAA
ATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCCAGCAGATCGTAATCGCTT
TGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATA
GTGTACGtGtGtCAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATTACTT
AGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTATCAGG
GCATTATGGTGTGTTGGGCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATTCGAA
ATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACTGTGAATGGTATTAAACGTGGT
ATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTATTAA
CTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGAT
CTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGACCCCT
ATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGCAGCGAT
CAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGGCTATTCATCAAGAAGCTGATATTATGGCAGCCC
AAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAA
GTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACAAGCACA
ACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACAGAAG
CCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACTGGTGGCTAAAAAAGCTCATTGCAATATCTAAGG
GACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATTTGGC
TAAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGTCTAG
AAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAACCTTAGCTAACGAAAAGGAATATCGC
CACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAAACCGCT
ATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAGAAACGAAACAACCTATTAGAAG
CTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTTGGCCAAACCTCTGAAATG
GTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTTATGG
CTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAAGt

SEQ ID NO: 26 amino acid sequence comprising 40a-RR (nat)

M S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q
E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H
L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E
H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E
T T R A Q D L V E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q
T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A
A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A P

SEQUENCE LISTING

Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K
 A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A Q
 F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y K
 K T H G N T R P S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A G
 A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S I K
 Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G F S
 T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G S T
 K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E A D
 I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T K
 G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L H
 Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N R L
 Q V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q S
 S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T V P
 D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L L
 E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K I T
 S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R

SEQ ID NO: 27 polynucleotide sequence comprising HIS-40a NH

ATGGGATCGCATCACCATCACCATCAGCTAGTAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAG
 AGCCTCAGGAGAAACGAAGGCGAGTAATACTCACGACGATAGTTTACCAAACCAGAAACAATTCAAGAGG
 CAAAGGCAACTATTGATGCAGTTGAAAAAACTCTCAGTCAACAAAAGCAGAACTGACAGAGCTTGCTACC
 GCTCTGACAAAACTACTGCTGAAATCAACCACTTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAAC
 CTCTGCACAAGAAATTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAAC
 ACAAAGAGAGTTAACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTTCAAAGAGACT
 GCATTTGTCAGAACAAAAGCTAGCATTTTCAGCAGAAACTACTCGAGCTCAAGATTTAGTGAACAAGTCAA
 AACGTCTGAACAAAATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTC
 AAACGGCTAATGATAATACAAAAGCATTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAA
 AAAGCTAAAGTTAAAAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGC
 AGAACTTAGTCGTCTTAAATCCTCAGCTCCGTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAG
 CACCGCAAGGCTATCCTCTTGAAGAAGCTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTAC
 AATAATTATTACAAAGAGCATGCAGATCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATA
 CCAAGATATTCCAGCAGATCGTAATCGCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGC
 TAGCGCAGTTTGCAGCTCACATGATTAATAGTGTAGAAGACAATTAGGTCTACCACCAGTTACTGTTACA
 GCAGGATCACAAGAATTTGCAAGATTACTTAGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATC
 ATTTGTCTACGGACAGCCAGGGGTATCAGGGCATTAATGGTGTGGGCCCTCATGATAAACTATTATTGAAG
 ACTCTGCCGGAGCGTCAGGGCTCATTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGAT
 GTGCATACTGTGAATGGTATTAAACGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTT
 ACACGGAAATACATACGGCCATGCTATTAACTTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTT
 ACCTTGGAATTTCAACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATT
 GCTAACCATCAACGCTTTAATAAGACCCCTATAAAAGCCGTTGGAAGTACAAAAGATATGCCCAAAGAGT
 AGGCACTGTATCTGATACTATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTCGGCTA
 TTCATCAAGAAGCTGATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACA
 CTTAAGCAGTCAGACAGCTTAAATCTCCAAGTGAGACAATTAATGATACTAAAGGTTCTTTGAGAACAGA
 ATTACTAGCAGCTAAAGCAAAACAAGCACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCAT
 CGTTGAAAGCCGCACTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACTGGTG
 GCTAAAAAGCTCATTTGCAATATCTAAGGGACTTTAAATTGAATCCTAACC GCCTTCAAGTGATACGTGA
 GCGCATTGATAATACTAAGCAAGATTTGGCTAAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAG
 CAGCCTTACAAGCTAAACAAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTT
 AAAACCTTAGCTAACGAAAAGGAATATCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGT
 AGCTCCACCTCTTACGGGCGTAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAA
 TGGTTAAAGAAACGAAACAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGTCTAAATCACATCTTCGAT
 TACTCAGCCCTCATCTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTG
 ATGAAAGTACTCAACGt

SEQ ID NO: 28 amino acid sequence comprising HIS-40a NH

SEQUENCE LISTING

M G S H H H H H H A S S V G V S H Q V K A D D R A S G E T K A S N T H D
 D S L P K P E T I Q E A K A T I D A V E K T L S Q Q K A E L T E L A T A
 L T K T T A E I N H L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S
 E E T L L A Q G A E H Q R E L T A T E T E L H N A Q A D Q H S K E T A L
 S E Q K A S I S A E T T R A Q D L V E Q V K T S E Q N I A K L N A M I S
 N P D A I T K A A Q T A N D N T K A L S S E L E K A K A D L E N Q K A K
 V K K Q L T E E L A A Q K A A L A E K E A E L S R L K S S A P S T Q D S
 I V G N N T M K A P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y
 K E H A D Q I I A K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L
 T P E V Q N E L A Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E
 F A R L L S T S Y K K T H G N T R P S F V Y G Q P G V S G H Y G V G P H
 D K T I I E D S A G A S G L I R N D D N M Y E N I G A F N D V H T V N G
 I K R G I Y D S I K Y M L F T D H L H G N T Y G H A I N F L R V D K H N
 P N A P V Y L G F S T S N V G S L N E H F V M F P E S N I A N H Q R F N
 K T P I K A V G S T K D Y A Q R V G T V S D T I A A I K G K V S S L E N
 R L S A I H Q E A D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N
 L Q V R Q L N D T K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A
 K L A S L K A A L H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L
 R D F K L N P N R L Q V I R E R I D N T K Q D L A K T T S S L L N A Q E
 A L A A L Q A K Q S S L E A T I A T T E H Q L T L L K T L A N E K E Y R
 H L D E D I A T V P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q
 E M V K E T K Q L L E A S A R L A A E N T S L V A E A L V G Q T S E M V
 A S N A I V S K I T S S I T Q P S S K T S Y G S G S S T T S N L I S D V
 D E S T Q R

SEQ ID NO: 29 polynucleotide sequence comprising HIS-40a CH

ATGGCTAGTAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAG
 TAATACTCACGACGATAGTTTACCAAACAGAAACAATTCAAGAGGCAAGGCAACTATTGATGCAGTTG
 AAAAAACTCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACGAAAACTACTGCTGAA
 ATCAACCAATTAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAA
 TACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTG
 AACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTCAGAACAAAAAGCTAGC
 ATTTACAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACCGTCTGAACAAAATATTGCTAA
 GCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAG
 CATTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAAAAAGCAATTG
 ACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTC
 AGCTCCGTCTACTCAAGATAGCATTTGTGGGTAAATAATACCATGAAAGCACCGCAAGGCTATCCTCTTGAAG
 AACTTAAAAAATTAGAAGCTAGTGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCA
 GATCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCCAGCAGATCGTAA
 TCGCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGA
 TTAATAGTGTAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGA
 TTAAGTAGTACCAGCTATAAGAAAATCATGGTAATACAAGACCATCATCTGTCTACGGACAGCCAGGGGT
 ATCAGGGCATTATGGTGTGGGCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCA
 TTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACTGTGAATGGTATTAAA
 CGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGC
 TATTAACTTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATG
 TAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAG
 ACCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGC
 AGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTCATCAAGAAGCTGATATTATGG
 CAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAAT
 CTCCAAGTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACA
 AGCACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGA
 CAGAAGCCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACTGGTGGCTAAAAAGCTCATTGCAATAT
 CTAAGGGACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGA
 TTTGGCTAAAACCTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCA
 GTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAACCTTAGCTAACGAAAAGGAA

SEQUENCE LISTING

TATCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTGTGCAAGTAGCTCCACCTCTTACGGGCGTAAA
 ACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAGAAACGAAACAACCTAT
 TAGAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTTGGCCAAACCTCT
 GAAATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATC
 TTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAACGtGCGGCCG
 CACTCGAGCACCACCACCACCACCAC

SEQ ID NO: 30 amino acid sequence comprising HIS-40a CH

M A S S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T
 I Q E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I
 N H L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G
 A E H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S
 A E T T R A Q D L V E Q V K T S E Q N I A K L N A M I S N P D A I T K A
 A Q T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E
 L A A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K
 A P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I
 A K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L
 A Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S
 Y K K T H G N T R P S ~~E~~ V Y G Q P G V S G H Y G V G P H D K T I I E D S
 A G A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S
 I K Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G
 F S T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G
 S T K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E
 A D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D
 T K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A
 L H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N
 R L Q V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K
 Q S S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T
 V P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q
 L L E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K
 I T S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R A A
 A L E H H H H H H

SEQ ID NO: 31 polynucleotide sequence comprising HIS-40a-RR NH

ATGGGATCGCATCACCATCACCATCAGCTAGTAGGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAG
 AGCCTCAGGAGAAACGAAGGCGAGTAATACTCACGACGATAGTTTACCAAACAGAAACAATTCAAGAGG
 CAAAGGCAACTATTGATGCAGTTGAAAAAATCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACC
 GCTCTGACAAAACTACTGCTGAAATCAACCACTTAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAAC
 CTCTGCACAAGAAATTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAAC
 ATCAAAGAGAGTTAACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGACT
 GCATTGTCAGAACAAAAAGCTAGCATTTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAA
 AACGTCTGAACAAAATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTC
 AAACGGCTAATGATAATACAAAAGCATTAAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAA
 AAAGCTAAAGTTAAAAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGC
 AGAACTTAGTCGTCTTAAATCCTCAGCTCCGTCTACTCAAGATAGCATTTGTGGGTAATAATACCATGAAAG
 CACCGCAAGGCTATCCTCTTGAAGAACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTAC
 AATAATTATTACAAAGAGCATGCAGATCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATA
 CCAAGATATTCCAGCAGATCGTAATCGCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAATGAGC
 TAGCGCAGTTTGCAGCTCACATGATTAATAGTGTAGtGtCAATTAGGTCTACCACCAGTTACTGTTACA
 GCAGGATCACAAGAATTTGCAAGATTACTTAGTACCAGCTATAAGAAAATCATGGTAATACAAGACCATC
 ATTTGTCTACGGACAGCCAGGGGTATCAGGGCATTATGGTGTGGGCCTCATGATAAACTATTATTGAAG
 ACTCTGCCGGAGCGTCAGGGCTCATTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGAT
 GTGCATACTGTGAATGGTATTAAACGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTT
 ACACGGAAATACATACGGCCATGCTATTAACTTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTT
 ACCTTGGAATTTTCAACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATT
 GCTAACCATCAACGCTTTAATAAGACCCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGT

SEQUENCE LISTING

AGGCACTGTATCTGATACTATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTCTGGCTA
 TTCATCAAGAAGCTGATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACA
 CTTAAGCAGTCAGACAGCTTAAATCTCCAAGTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGA
 ATTACTAGCAGCTAAAGCAAAACAAGCACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCAT
 CGTTGAAAGCCGCACTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGCGAGCCAGAGTGACAGCACTGGTG
 GCTAAAAAAGCTCATTTGCAATATCTAAGGGACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGA
 GCGCATTGATAATACTAAGCAAGATTGGGCTAAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAG
 CAGCCTTACAAGCTAAACAAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTT
 AAAACCTTAGCTAACGAAAAGGAATATCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGT
 AGCTCCACCTCTTACGGGCGTAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAA
 TGGTTAAAGAAACGAAACAACCTATTAGAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCA
 GAAGCGCTTGTTGGCCAAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGAT
 TACTCAGCCCTCATCTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTG
 ATGAAAGTACTCAACGt

SEQ ID NO: 32 amino acid sequence comprising HIS-40a-RR NH

M G S H H H H H A S S V G V S H Q V K A D D R A S G E T K A S N T H D
 D S L P K P E T I Q E A K A T I D A V E K T L S Q Q K A E L T E L A T A
 L T K T T A E I N H L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S
 E E T L L A Q G A E H Q R E L T A T E T E L H N A Q A D Q H S K E T A L
 S E Q K A S I S A E T T R A Q D L V E Q V K T S E Q N I A K L N A M I S
 N P D A I T K A A Q T A N D N T K A L S S E L E K A K A D L E N Q K A K
 V K K Q L T E E L A A Q K A A L A E K E A E L S R L K S S A P S T Q D S
 I V G N N T M K A P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y
 K E H A D Q I I A K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L
 T P E V Q N E L A Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E
 F A R L L S T S Y K K T H G N T R P S F V Y G Q P G V S G H Y G V G P H
 D K T I I E D S A G A S G L I R N D D N M Y E N I G A F N D V H T V N G
 I K R G I Y D S I K Y M L F T D H L H G N T Y G H A I N F L R V D K H N
 P N A P V Y L G F S T S N V G S L N E H F V M F P E S N I A N H Q R F N
 K T P I K A V G S T K D Y A Q R V G T V S D T I A A I K G K V S S L E N
 R L S A I H Q E A D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N
 L Q V R Q L N D T K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A
 K L A S L K A A L H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L
 R D F K L N P N R L Q V I R E R I D N T K Q D L A K T T S S L L N A Q E
 A L A A L Q A K Q S S L E A T I A T T E H Q L T L L K T L A N E K E Y R
 H L D E D I A T V P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q
 E M V K E T K Q L L E A S A R L A A E N T S L V A E A L V G Q T S E M V
 A S N A I V S K I T S S I T Q P S S K T S Y G S G S S T T S N L I S D V
 D E S T Q R

SEQ ID NO: 33 polynucleotide sequence comprising 40N-HIS

ATGCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATACTCACGACGATAGTTTACC
 AAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAAACTCTCAGTCAACAAAAG
 CAGAACTGACAGAGCTTGCTACCGCTCTGACAAAACTACTGCTGAAATCAACCACTTAAAAGAGCAGCAA
 GATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCTTGCAAGTAGTGAGGAGAC
 GCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAGAGCTTCATAATGCTCAAG
 CAGATCAACATTCAAAGAGAGCTGCATTGTGAGAACAAGCTAGCATTTTCAGCAGAAACTACTCGAGCT
 CAAGATTTAGTGGAACAAGTCAAAACGTCTGAACAAAATATTGCTAAGCTCAATGCTATGATTAGCAATCC
 TGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTAAGCTCAGAATTGGAGAAGG
 CTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAAAAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAA
 GCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTCAGCTCCGCTACTCAAGATAGCAT
 TGTGGGTAATAATACCATGAAAGCACCGCAAGGCTATCCTCTTGAAGAAGTTAAAAAATTAGAAGCTAGTG
 GTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGATCAAATTATTGCCAAAGCTAGT
 CCAGGTAATCAATTAAATCAATACCAAGCGGCCGCACTCGAGCACCACCACCACCACCAC

SEQUENCE LISTING

SEQ ID NO: 34 amino acid sequence comprising 40N-HIS

M Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q E A K A T I
D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H L K E Q Q D
N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E H Q R E L T
A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E T T R A Q D
L V E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q T A N D N T
K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A A Q K A A L
A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A P Q G Y P L E
E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K A S P G N Q
L N Q Y Q A A A L E H H H H H H H

SEQ ID NO: 35 amino acid sequence comprising GAS 117

MTLKKHYLLSLLALVTVGAAFNTSQSVSAQVYSNEGYHQHLTDEKSHLQYSKDNAQLQLRNILDGYQNDL
GRHYSSYYYNLRTVMGLSSEQDIEKHYEELKNKLHDMYNHY

SEQ ID NO: 36 polynucleotide sequence encoding GAS 117

ATGACACTAAAAAACACTATTATCTTCTCAGCCTGCTAGCTCTTGTAACGGTTGGTGCTGCCTTTAACAC
AAGCCAGAGTGTCAGTGCACAAGTTTATAGCAATGAAGGGTATCACCAGCATTTGACTGATGAAAAATCAC
ACCTGCAATATAGTAAAGACAACGCACAACCTTCAATTGAGAAATATCCTTGACGGCTACCAAATGACCTA
GGGAGACACTACTCTAGCTATTATTACTACAACCTAAGAACCGTTATGGGACTATCAAGTGAGCAAGACAT
TGAAAAACACTATGAAGAGCTTAAGAACAAGTTACATGATATGTACAATCATTATTAA

SEQ ID NO: 37 amino acid sequence comprising GAS 117 leader sequence

TLKKHYLLSLLALVTVGA

SEQ ID NO: 38 amino acid sequence comprising fragment of GAS 117 where leader sequence is removed

AFNTSQSVSAQVYSNEGYHQHLTDEKSHLQYSKDNAQLQLRNILDGYQNDLGRHYSSYYYNLRTVMGLSS
EQDIEKHYEELKNKLHDMYNHY

SEQ ID NO: 39 amino acid sequence comprising GAS 130

MSHMKKRPEVLSPAGTLEKLKVAIDYGADAVFVGGQAYGLRSRAGNFSMEELQEGIDYAHARGAKVYVAAN
MVTHEGNEIGAGEWFRQLRDMGLDAVIVSDPALIVICSTEAPGLEIHLSTQASSTNYETFEFWKAMGLTRV
VLAREVNMAELAEIRKRTDVEIEAFVHGAMCISYSGRCVLSNHMSHRDANRGGSQSCRWKYDLYDMPFGG
ERRSLKGEIPEDYSMSSVDMCMIDHIPDLIENGVDLSKIEGRMKS IHYVSTVTNICYKAAVGAYMESPEAFY
AIKEELIDELWKVAQRELATGFYYGIPTENEQLFGARRKIPQYKFVGEVVAFDSASMTATIRQRNVIMEGD
RIECYGPGRHFETVVKDLHDADGQKIDRAPNPMELLTISLPREVKPGDMIRACKEGLVNLYQKDGTSTKV
RT

SEQ ID NO: 40 polynucleotide sequence encoding GAS 130

ATGTCACATATGAAAAACGTCCCGAGGTCTTATCACCTGCTGGAACACTTGAAAAATTAAAAGTTGCGAT
TGACTATGGCGCAGATGCTGTTTTTGTGGAGGGCAGGCCTATGGCCTAAGAAGCCGCGCTGGTAACTTCT
CTATGGAAGAATTGCAAGAAGGCATTGATTATGCACATGCGCGTGGAGCTAAGGTCTATGTTGCTGCTAAC
ATGGTTACCCACGAAGGGAACGAAATTGGTGCGGGCGAGTGGTTTCGTCAACTGCGTGATATGGGGCTTGA
TGCGGTCATTGTTTCAGATCCAGCCTTGATTGTTATTTGTTCAACAGAAGCCCCAGGTTTGGAATTCATT
TGTCACGCAAGCTTCATCTACCAATTACGAGACCTTTGAATTTTGGAAGCCATGGGCTTGACCCGAGTT
GTTTTAGCTCGCGAGGTTAATATGGCCGAGTTAGCAGAAATCCGCAAGCGGACAGATGTGGAATTTGAAGC
CTTTGTCCATGGAGCCATGTGTATCTCTTATTCAGGCCGCTGTGTTTTGTCAAACCACATGAGTCACCGTG
ATGCCAACAGGGGCGGCTGCTCACAGTCTTGCCGCTGGAAGTATGATTTGTATGACATGCCATTTGGAGGA
GAGCGCCGCTCCTTAAAAGGGGAAATTCAGAAGACTATTCTATGTCTCTGTGACATGTGTATGATTGA
CCATATTCCTGACCTGATTGAAAATGGGGTTGATAGCTTAAAAATTGAAGGCCGAATGAAATCTATCCACT
ACGTCTCAACCGTAACCAACTGTTACAAGGCGGCTGTAGGTGCTTACATGGAAAGCCCAGAAGCTTTTTAT
GCTATCAAAGAGGAATTGATTGACGAGTTGTGGAAGGTTGCCAGCGGAGTTGGCTACAGGTTTTTACTA
TGGTATCCCAACTGAAAATGAACAATTATTTGGTGCTCGCCGCAAAATTCACAATATAAATTTGTCGGAG
AAGTAGTTGCCTTTGACTCAGCTAGCATGACAGCGACCATTCGTCAGCGTAATGTCATCATGGAAGGCGAT

SEQUENCE LISTING

CGGATTGAATGTTATGGACCAGGTTTCCGTCATTTTGAAACGGTTGTTAAGGACTTACATGATGCGGATGG
 CCAAAGATTGACCGTGCCCCAAATCCAATGGAACCTTTAACCATCTCTTTACCGAGAGAAGTTAAGCCAG
 GGGATATGATTAGGGCTTGCAAGGAAGGTCTGGTTAACCTCTATCAAAAAGATGGCACCAGTAAACTGTT
 AGAACATAG

SEQ ID NO: 41 amino acid sequence comprising GAS 277

MTTMQKTISLLSLALLIGLLGTSGKAISVYAQDQHTDNVIAESTISQVSVEASMRGTEPYIDATVTTDQPV
 RQPTQATITLKDASDNTINSWVYTMAAQRRFTAWFDLTGQKSGDYHVTVTVHTQEKA VTGQSGTVHFDQN
 KARKTPTNMQQKDT SKAMTNSVDVDTKAQTNQSANQEIDSTSNPFRSATNHRSTSLKRSTKNEKLTPASN
 SQKNGSNKTKMLVDKEEVKPTSKRGFPWVLLGLVVS LAAGLFIAIQVSRRK

SEQ ID NO: 42 polynucleotide sequence encoding GAS 277

ATGACAAC TATGCAAAAACAATTAGCTTATTATCACTAGCTTTACTTATTGGTTTGCTGGGGACTTCTGG
 CAAAGCCATATCTGTGTATGCACAAGATCAGCACACTGATAATGTTATAGCTGAATCAACTATTAGTCAGG
 TCAGTGTGTAAGCCAGTATGCGTGGAACAGAACCTTATATTGATGCTACAGTCACCACAGATCAACCTGTC
 AGACAACCAACTCAGGCAACGATAACACTTAAAGACGCTAGTGATAATACTATTAATAGTTGGGTATATAC
 TATGGCAGCGCAACAGCGTCGTTTACAGCTTGGTTTGATTAACTGGACAAAAGAGTGGTGACTATCATG
 TAACTGTCACCGTTCATACTCAAGAAAAGGCAGTAACTGGTCAATCAGGAAC TGTTCATTTTGATCAAAAC
 AAAGCTAGAAAAACACCAACTAATATGCAACAAAAGGATACTTCTAAAGCAATGACGAATTCAGTCGATGT
 AGACACAAAAGCTCAAACAAATCAATCAGCTAACCAAGAAATAGATTCTACTTCAAATCCTTTCAGATCAG
 CTACTAATCATCGATCAACTTCCTTAAAGCGATCTACTAAAAATGAGAACTTACACCAACTGCTAGTAAT
 AGCCAAAAAACGGTAGCAACAAGACAAAAATGCTAGTGGACAAAGAGGAAGTAAACCTACTTCAAAAAG
 AGGATTCCCTTGGGTCTTATTAGGTCTAGTAGTCAGTTTAGCTGCAGGTTTATTTATAGCTATTCAAAAAG
 TATCTAGACGAAAATAA

SEQ ID NO: 43 amino acid sequence comprising N-terminal leader sequence of GAS 277

TTMQKTISLLSLALLIGLLGTSGKAISVYA

SEQ ID NO: 44 amino acid sequence comprising fragment of GAS 277 where N-terminal leader sequence is removed

QDQHTDNVIAESTISQVSVEASMRGTEPYIDATVTTDQPV RQPTQATITLKDASDNTINSWVYTMAAQRR
 FTAWFDLTGQKSGDYHVTVTVHTQEKA VTGQSGTVHFDQNKARKTPTNMQQKDT SKAMTNSVDVDTKAQTN
 QSANQEIDSTSNPFRSATNHRSTSLKRSTKNEKLTPASNSQKNGSNKTKMLVDKEEVKPTSKRGFPWVLL
 GLVVS LAAGLFIAIQVSRRK

SEQ ID NO: 45 amino acid sequence comprising GAS 236

MTQMNYTGKVKRVAIIANGKYQSKRVASKLFSVFKDDPDFYLSKKNPDIVISIGGDGMLLSAFHMYEKELD
 KVRFGIHTGHLGFYTDYRDFEVDKLIDNLRKDKGEQISYPILKVAITLDDGRVVKARALNEATVKRIEKT
 MVADVIIINHVKFESFRGDGISVSTPTGSTAYNKS LGGAVLHPTIEALQLTEISSLNNRVFRTLGSIIIPK
 KDKIELVPKRLGIYTI SIDNKTYQLKNVTKVEYFIDDEKIH FVSSPHTSFWERVKDAFIGEIDS

SEQ ID NO: 46 polynucleotide sequence encoding GAS 236

ATGACACAGATGAATTATACAGGTAAGGTAACGAGTTGCTATTATTGCAAATGGTAAGTACCAAAGTAA
 ACGCGTCGCCTCCAAACTTTTCTCCGTATTTAAAGATGATCCTGATTTCTATCTTTCAAAGAAAAATCCGG
 ATATTGTGATTTCTATTGGCGGAGATGGGATGCTCTTATCTGCCTTTCACATGTATGAAAAAGAATTAGAT
 AAGGTACGTTTTGTAGGAATCCACACCGGTCATCTTGGCTTTTATACCGATTATAGGGATTTTGAAGTTGA
 TAAATTAATTGATAATTTAAGAAAAGACAAGGGAGAACAAATCTCTTATCCGATTTTAAAAGTTGCTATTA
 CTTTAGATGATGGTCGTGTGGTTAAAGCGCGTGCTTTGAATGAAGCGACGGTTAAGCGTATTGAAAAACG
 ATGGTAGCAGATGTTATTATTAACCATGTCAAATTTGAAAGCTTCCGAGGTGATGGGATTTTCAGTATCGAC
 CCCGACAGGGAGCACAGCCTACAATAAATCTTTAGGTGGTGCTGTCTTG CATCCGACGATTGAAGCGCTGC
 AATTGACGGAAATTTCCAGTCTTAATAACCGTGTCTTTAGAACCTTGGGCTCATCAATCATTATCCCAA
 AAAGATAAGATTGAGTTAGTGCCAAAACGATTAGGAATTTATACCATTTCATTGATAATAAACCTATCA
 GTTAAAAAATGTGACGAAGGTGGAGTATTTTATCGACGATGAGAAAATTCATTTTGTTTCTCTCCGAGTC
 ATACGAGCTTTTGGGAAAGGGTCAAGGATGCCTTTATTGGAGAGATTGACTCATGA

SEQUENCE LISTING

SEQ ID NO: 47 amino acid sequence comprising N-terminus leader sequence of GAS 236
MTQM

SEQ ID NO: 48 amino acid sequence comprising a fragment of GAS 236 where the N-terminal leader sequence is removed

NYTGKVKRVAI IANGKYQSKRVASKLFSVFKDDPDFYLSKKNPDIVISIGGDGMLLSAFHMYEKELDKVRF
VGIHTGHLGFYTDYRDFEVDKLIDNLRKDKGEQISYPILKVAITLDDGRVVKARALNEATVKRIEKTMTVAD
VIINHVKFESFRGDGISVSTPTGSTAYNKS LGGAVLHPTIEALQLTEISSLNNRVFRTLGSIIIPKKDKI
ELVPKRLGIYITISIDNKTYQLKNVTKVEYFIDDEKIHVSSPSHTSFWERVKDAFIGEIDS

SEQ ID NO: 49 amino acid sequence comprising GAS 389

MRNEMAKIMNVTGEEVIALAATYMTKADVAFVAKALAYATAAHFYQVRKSGEPYIVHPIQVAGILADLHLD
AVTVACGFLHDVVEDTDITLDEIEADFGHDARDIVDGVTKLGEVEYKSHEEQLAENHRKMLMAMSKDIRVI
LVKLADRLHNMRTLKHLRKDKQERISRETMEIYAPLAHRLGISRIKWELEDLAFRYLNTEFEYKISHMMKE
KRREREALVEAIVSKVKTYTTQOGLFGDVYGRPKHIYSIYRKMRDKKKRFDDQIFDLIAIRCVMETQSDVYA
MVGYIHELWRPMPGRFKDYIAAPKANGYQSIHTTVYGPKGPIEQIRTKDMHQVAEYGVAAHWAYKKGVRG
KVNQAEQAVGMNWIKELEVELQDASNGDAVDFVDSVKEDIFSERIYVFTPTGAVQELPKESGPIDFAYAIHT
QIGEKATGAKVNGRMVPLTAKLKTGDVVEIITNANSFGPSRDWVKLVKTNKARNKIRQFFKNQDKELSVNK
GRDLLVS YFQEQGYVANKYLDKKRIEAILPKVS VKSEESLYAAVGFGDISPISVFNKLTEKERREEERAKA
KAEAEELVKGGEVKHENKDV LKVRSENGV I IQGASGLLMRIAKCCNPVPGDPIDGYITKGRGIAIHRSDCH
NIKSQDGYQERLIEVEWDLDNSSKDYQAEIDIYGLNRSGLLNDVLQILSNSTKSISTVNAQPTKDMKFANI
HVSFGIPNLTHLT TVVEKIKAVPDVYSVKRTNG

SEQ ID NO: 50 polynucleotide sequence encoding GAS 389

ATGAGGAACGAAATGGCAAAAATAATGAACGTAACAGGAGAAGAAGTCATTGCCTTAGCGGCCACCTATAT
GACCAAGGCTGATGTGGCTTTTGTGGCAAAGGCTTTAGCATATGCAACAGCGGCCCATTTCTACCAAGTGA
GAAAGTCAGGCGAACCCCTATATCGTCCATCCGATTCAGGTGGCGGGGATTCTGGCTGATTTGCATCTGGAT
GCTGTGACAGTTGCTTGTGGCTTTTACATGATGTCGTAGAAGATACGGATATTACCTTAGATGAGATCGA
AGCAGACTTTGGCCATGATGCTCGTGATATCGTTGATGGTGTCAACCAAGTTAGGTGAAGTTGAGTACAAAT
CTCATGAGGAGCAACTCGCCGAAAACCATCGCAAAATGCTGATGGCTATGTCCAAAGATATTCGCGTGATT
TTGGTGAAATTGGCTGACCGCCTGCATAATATGCGCACCCCTCAAACATTTGCGCAAGGACAAACAAGAGCG
CATTTGCGCGCAAACCATGGAAATCTATGCCCCCTTGCGCATCGTTTGGGGATTAGTCGCATCAAATGGG
AACTAGAAGATTTGGCTTTTCGTTACCTCAATGAAACCGAATTTTACAAAATTTCCCATATGATGAAAGAA
AAACGTCGCGAGCGTGAAGCTTTGGTAGAGGCTATTGTCAGTAAGGTCAAACCTATACGACACAACAAGG
GTTGTTTGGAGATGTGTATGGCCGACCAAAACACATTTATTCGATTTATCGGAAAATGCGGGACAAAAAGA
AACGATTCGATCAGATTTTGTATCTGATTGCCATTCGTTGTGTCATGGAAACGCAAAGCGATGTCCTATGCT
ATGGTTGGCTATATTCATGAGCTTTGGCGTCCCATGCCAGGCCGCTTCAAGGATTATATTGCAGCTCCTAA
AGCTAATGGCTACCAGTCTATTACATACCACCGTGTATGGGCCAAAAGGACCTATTGAGATTCAAATCAGAA
CTAAGGACATGCATCAAGTGGCTGAGTACGGGGTTGCTGCTCACTGGGCTTATAAAAAGGCGTGCGTGGT
AAGGTCAATCAAGCTGAGCAAGCCGTTGGCATGAACTGGATCAAAGAGCTGGTAGAATTGCAAGATGCCTC
AAATGGCGATGCAGTGGACTTTGTGGATTCCGTCAAAGAAGACATTTTTTCTGAACGGATTTATGTCTTTA
CACCGACAGGGGCCGTTACAGGAGTTACCAAAAGAATCAGGTCCTATTGATTTTGCTTATGCGATCCATACG
CAAATCGGTGAAAAAGCAACAGGTGCCAAAGTCAATGGACGTATGGTTCTCTCACTGCCAAGTTAAAAAC
AGGAGATGTGGTTGAAATCATACCAATGCCAATTCCTTTGGCCCTAGTCGAGACTGGGTAAACTGGTCA
AAACCAATAAGGCTCGCAACAAAATTCGTCAGTTCTTTAAAAATCAAGACAAGGAATTGTCAGTGAATAAA
GGCCGTGATTTGTTGGTGTCTTATTTTCAAGAGCAGGGCTACGTTGCCAATAAATACCTTGACAAAAAACG
CATTGAAGCCATCCTTCCAAAAGTCAGTGTGAAGAGCGAAGAATCACTCTATGCAGCCGTTGGGTTTGGTG
ACATTAGTCCATCAGTGTCTTTAACAAGTTAACCAGAAAAGAGCGCCGTGAAGAAGAAAGGGCCAAGGCT
AAAGCAGAAGCTGAAGAATTGGTTAAGGGCGGTGAGGTCAAACACGAAAACAAAGATGTGCTCAAGGTTTCG
CAGTGAAAATGGAGTCATTATCCAAGGAGCATCAGGCCTCTTGATGCGGATTGCCAAGTGTGTAATCCTG
TACCTGGTGATCCTATTGACGGCTACATTACCAAGGGCGTGGCATTGCGATTACAGATCGGACTGTCAT
AACATTAAGAGTCAAGATGGCTACCAAGAACGCTTGATTGAGGTGAGTGGGATTTGGACAATTCGAGTAA
AGATTATCAGGCTGAAATTGATATCTATGGGCTCAATCGTAGTGGTCTGCTTAATGATGTGCTCCAAATTT
TATCAAACCTCAACCAAGAGCATATCGACAGTCAATGCTCAGCCGACCAAGGACATGAAGTTTGCTAATATT
CACGTGAGCTTTGGCATTCCAAATCTGACGCATCTGACCACTGTTGTGCGAAAAATCAAGGCAGTTCAGAA
TGTTTATAGCGTGAAGCGGACCAATGGCTAA

SEQUENCE LISTING

SEQ ID NO: 51 amino acid sequence comprising GAS 504

MKTRITELLNIDYPIFQGGMAWVADGDLGAVSNAGGLGIIGGGNAPKEVVKANIDRVKAITDRPFGVNIM
 LLSPFADDDIVDLVIEEGVKVVTGAGNPGKYMERLHQAGIIVVPVPSVALAKRMEKLGVDVIAEGMEAG
 GHIGKLTMSLVRQVVEAVSIPVIAAGGIADGHGAAAFAFLGAEAVQIGTRFVAKESNAHQNFKDILAA
 KDIDTVISAQVVGHPVRSIKNKLTSAYAKAEKAFLIGQKTATDIEEMGAGSLRHAVIEGDVVNGSVMAGQI
 AGLVRKEESCETILKDIYYGAARVIQNEAKRWQSVSIEK

SEQ ID NO: 52 polynucleotide sequence encoding GAS 504

ATGAAAACACGTATTACAGAATTACTTAATATTGATTACCCCATTTTCAAGGAGGAATGGCTTGGGTTGC
 TGATGGTGATTTAGCAGGTGCAGTTTCTAATGCTGGTGGTTTAGGCATTATAGGTGGTGGCAATGCTCCCA
 AAGAAGTCGTTAAAGCTAATATTGATCGTGTCAAAGCTATTACTGATAGACCTTTTGGGGTTAATATCATG
 CTTTTATCTCCTTTTGGCTGATGATATCGTTGATCTGGTCATTGAAGAAGGTGTTAAAGTAGTAACAACAGG
 CGCAGGAAATCCAGGAAAGTATATGGAAAGACTGCACCAGGCGGGTATAATCGTTGTTCCCTGTTGTCCCAA
 GCGTTGCGCTAGCCAAACGTATGGAAAAGCTTGGGGTAGATGCTGTTATTGCTGAGGGTATGGAAGCTGGA
 GGACATATTGGCAAGTTAACGACTATGCTTTAGTAAGACAAGTTGTTGAAGCGGTTTCGATTCCTGTCAT
 TGCGGCAGGTGGTATAGCTGATGGTCATGGTGCAGCAGCAGCATTTATGTTAGGAGCAGAGGCTGTTCAAA
 TTGGAACCTCGCTTTGTTGTTGCTAAAGAATCCAATGCTCACCAAAATTTTAAAGATAAAATCTTAGCAGCA
 AAAGATATTGATACGGTGATTTCTGCGCAGGTGTGGGCCACCCTGTCCGTTCTATTAAAAATAAATTGAC
 CTCAGCTTACGCTAAAGCAGAAAAAGCATTTTTAATTGGTCAAAAAACAGCTACTGATATTGAAGAAATGG
 GAGCAGGATCGCTTCGACACGCTGTTATTGAAGGCGATGTAGTCAATGGATCTGTTATGGCTGGCCAAATT
 GCAGGGCTTGTGAGAAAAGAAGAAAGCTGTGAAACGATTTTAAAGATATTTATTATGGTGCAGCTCGTGT
 TATTCAAAATGAAGCTAAGCGCTGGCAATCTGTTTCAATAGAAAAGTAG

SEQ ID NO: 53 amino acid sequence comprising GAS 509

MTKIYKTITELVGQTPIIKLNRLIPNEAADVYVKLEAFNPGSSVKDRIALSMIEAAEAEGGLISPGDVIIIE
 PTSGNTGIGLAWVGAAGGYRVIIVMPETMSLERRQIIQAYGAELVLTPGAEGMKGAIAKAETLAIELGAW
 MPMQFNPNPANSIHEKTTAQEILEAFKEISLDAFVSGVGTGGTSLGVSHVLKKNPETHVIYAVEAEESAV
 LSGQEPGPHKIQGISAGFIPNTLDTKAYDQIIIRVKS KDALETARLTGAKEGFLVGIISSGAALYAAIEVAK
QLGKGKHVLTILPDNGERYLSTELYDVPVIKTK

SEQ ID NO: 54 polynucleotide sequence encoding GAS 509

ATGACTAAAATTTACAAAACCTATAACAGAATTAGTAGGTCAAACACCTATTATCAAACCTTAACCGTTTAA
 TTCCAAACGAAGCTGCTGACGTTTATGTAAAATTAGAAGCTTTTAACCCAGGATCTTCTGTTAAAGATCG
 TATTGCTTTATCGATGATTGAAGCTGCTGAAGCTGAAGGTCTGATAAGTCCTGGTGACGTTATTATCGAA
 CCAACAAGTGGTAATACAGGTATTGGTCTTGCAATGGGTAGGTGCTGCTAAAGGGTATCGAGTCATTATTG
 TTATGCCCGAAACTATGAGCTTGGAAGACGGCAAATCATTCAGGCTTATGGTGCAGAGCTTGTCTTAAC
 ACCTGGAGCAGAAGGTATGAAAGGGGCTATTGCAAAGCTGAAACTTTAGCAATAGAACTAGGTGCTTGG
 ATGCCATATGCAATTTAATAACCCTGCCAATCCAAGCATCCATGAAAAACAACAGCTCAAGAAATTTTGG
 AAGCTTTTAAGGAGATTTCTTTAGATGCATTCGTATCTGGTGTGGTACTGGAGGAACACTTTCTGGTGT
 TTCACATGTCTTGAAAAAGCTAACCCTGAAACTGTTATCTATGCTGTTGAAGCTGAAGAACTGCTGCTC
 TTATCTGGTCAAGAGCCTGGACCACATAAAATTCAAGGTATATCAGCTGGATTTATCCCAAACACGTTAG
 ATACCAAAGCCTATGACCAAATTATCCGTGTTAAATCGAAAGATGCTTTAGAAACTGCTCGACTAACAGG
 AGCTAAGGAAGGCTTCCTGGTTGGGATTTCTTCTGGAGCTGCTCTTTACGCCGCTATTGAAGTCGCTAAA
CAGTTAGGAAAAGGCAAACATGTGTTAACTATTTTACCAGATAATGGCGAACGCTATTTATCGACTGAAC
TCTATGATGTACCAGTAATTAAGACGAAATAA

SEQ ID NO: 55 amino acid sequence comprising C-terminus transmembrane region of GAS 509

FLVGIISSGAALYAAIEVAKQLGKGKHVLTILPDNGERYLSTELYDVPVIKTK

SEQ ID NO: 56 amino acid sequencing comprising a fragment of GAS 509 where the C-terminal transmembrane region is removed

MTKIYKTITELVGQTPIIKLNRLIPNEAADVYVKLEAFNPGSSVKDRIALSMIEAAEAEGGLISPGDVIIIEP
 TSGNTGIGLAWVGAAGGYRVIIVMPETMSLERRQIIQAYGAELVLTPGAEGMKGAIAKAETLAIELGAWMP

SEQUENCE LISTING

MQFNPNPANPSIHEKTTAQEILEAFKEISLDAFVSGVGTGGTLSGVSHVLKKANPETVIYAVEAEESAVALSG
QEPGPHKIQGISAGFIPNTLDTKAYDQIIRVKSKDALETARLTGAKEG

SEQ ID NO: 57 amino acid sequence comprising GAS 366

MKVISNFQNKILILGLAKSGEAAAKLLTKLGALVTVNDSPFDQNPAAQALLEEGIKVICGSHPVVELLDE
NFEYMKVKNPGIPYDNPMVKRALAKEIPILTEVELAYFVSEAPIIGITGSNGKTTTTMIADVLNAGGQSAL
LSGNIGYPASKVVQKAIAGDTLVMELSSFQLVGVNAFRPHIAVITNLMPTHLDYHGSEFEDYVAAKWMIIQAQ
MTESDYILILNANQEISATLAKTTKATVIPFSTQKVVDGAYLKDGLYFKEQAIIAATDLGVPGSHNIENAL
ATIAVAKLSGIADDIIAQCLSHFGGVKHLRQVRVGQIKDITFYNDKSTNILATQKALSGFDNSRLILIAGG
LDRGNEFDDLVPDLLGLKQMIILGESAERMKRAANKAEVSYLEARNVAEATELAFKLAQTGDTILLSPANAS
SWDMYPNFEVRGDEFLLATFDCLRGDA

SEQ ID NO: 58 polynucleotide sequence encoding GAS 366

ATGAAAGTGATAAGTAATTTTCAAAACAAAAAATATTAATATTGGGGTTAGCCAAATCGGGCGAAGCAGC
AGCAAAATTATTGACCAAACTTGGTGCTTTAGTGACTGTTAATGATAGTAAACCATTTGACCAAAATCCAG
CGGCACAAGCCTTGTTGGAAGAGGGGATTAAGGTCATTTGTGGTAGCCACCCAGTAGAATTATTAGATGAG
AACTTTGAGTACATGGTTAAAAACCCTGGGATTCCTTATGATAATCCTATGGTTAAACGCGCCCTTGCAAA
GGAAATTCCCATTCTTGACTGAAGTAGAATTGGCTTATTTTCGTATCTGAAGCGCCTATTATCGGGATTACAG
GATCAAACGGGAAGACAACCACAACGACAATGATTGCCGATGTTTTGAATGCTGGCGGGCAATCTGCACTC
TTATCTGGAAACATTGGTTATCCTGCTTCAAAAGTTGTTCAAAAAGCAATTGCTGGTGATACTTTGGTGAT
GGAATTGTCCTCTTTTCAATTAGTGGGAGTGAATGCTTTTCGCCCTCATATTGCTGTCATCACTAATTTAA
TGCCGACTCACCTGGACTATCATGGCAGTTTTGAGGATTATGTTGCTGCTAAATGGATGATTCAAGCTCAG
ATGACAGAATCAGACTACCTTATTTTAAATGCTAATCAAGAGATTTTCAGCAACTCTAGCTAAGACCACCAA
AGCAACAGTGATTCTTTTCAACTCAAAAAGTGGTTGATGGAGCTTATCTGAAGGATGGAATACTCTATT
TTAAAGAACAGGCGATTATAGCTGCAACTGACTTAGGTGTCCAGGTAGCCACAACATTGAAAATGCCCTA
GCAACTATTGCAGTTGCCAAGTTATCTGGTATTGCTGATGATATTATTGCCCAGTGCCCTTTCACATTTTGG
AGGCGTTAAACATCGTTTGCAACGGGTTGGTCAAATCAAAGATATTACCTTCTACAATGACAGTAAGTCAA
CCAATATTTTAGCCACTCAAAAAGCTTTATCAGGTTTTGATAACAGTCGCTTGATTTTGATTGCTGGCGGT
CTAGATCGTGGCAATGAATTTGACGATTGGTGCCAGACCTTTTAGGACTTAAGCAGATGATTATTTTGGG
AGAATCCGCAGAGCGTATGAAGCGAGCTGCTAACAAAGCAGAGGTCTCTTATCTTGAAGCTAGAAATGTGG
CAGAAGCAACAGAGCTTGCTTTTAAGCTGGCCCAAACAGGCGATACTATCTTGCTTAGCCCAGCCAATGCT
AGCTGGGATATGTATCCTAATTTTGAGGTTCTGTTGGGATGAATTTTGGCAACCTTTGATTGTTTAAGAGG
AGATGCCTAA

SEQ ID NO: 59 amino acid sequence comprising N-terminal leader sequence of GAS 366

MKVISNFQNKILILGLAKSGEAAA

SEQ ID NO: 60 amino acid sequence comprising a fragment of GAS 366 where the N-terminal leader sequence is removed

KLLTKLGALVTVNDSPFDQNPAAQALLEEGIKVICGSHPVVELLDENFEYMKVKNPGIPYDNPMVKRALAKE
IPILTEVELAYFVSEAPIIGITGSNGKTTTTMIADVLNAGGQSALLSGNIGYPASKVVQKAIAGDTLVMEL
LSSFQLVGVNAFRPHIAVITNLMPTHLDYHGSEFEDYVAAKWMIIQAQMTESDYILILNANQEISATLAKTTKA
TVIPFSTQKVVDGAYLKDGLYFKEQAIIAATDLGVPGSHNIENALATIAVAKLSGIADDIIAQCLSHFGG
VKHLRQVRVGQIKDITFYNDKSTNILATQKALSGFDNSRLILIAGGLDRGNEFDDLVPDLLGLKQMIILGE
SAERMKRAANKAEVSYLEARNVAEATELAFKLAQTGDTILLSPANASWDMYPNFEVRGDEFLLATFDCLRGD
A

SEQ ID NO: 61 amino acid sequence comprising GAS 159

MRKLYSFLAGVLGVIVILTSLSFILQKKSGSGSQSDKLVIYNWGDYIDPALLKKFTKETGIEVQYETFDN
EAMYTKIKQGGTTYDIAVPSDYTIDKMIKENLLNKLDKSKLVGMDNIGKEFLGKSFDQNDYSLPYFWGTV
GIVYNDQLVDKAPMHWEDLWRPEYKNSIMLIDGAREMLGVGLTTFGYSVNSKNLEQLQAAERKLQQLTPNV
KAIVADEMKGYMIQGDAAGITFSGEASEMLDSNEHLHYIVPSEGSNLWFDNLVLPKTMKHEKEAYAFNLF
INRPENAAQNAAYIGYATPNKKAKALLPDEIKNDPAFYPTDDI IKKLEVYDNLGSRWLGIYNDLYLQFKMY
RK

SEQUENCE LISTING**SEQ ID NO: 62** polynucleotide sequence encoding GAS 159

ATGCGTAAACTTTATTCTTTCTAGCAGGAGTTTGGGTGTTATTGTTATTTTAACAAGTCTTTCTTTCAT
 CTTGCAGAAAAAATCGGGTTCTGGTAGTCAATCGGATAAATTAGTTATTTATAACTGGGGAGATTACATTG
 ATCCAGCTTTGCTCAAAAAATTCACCAAAGAAACGGGCATTGAAGTGCAGTATGAAACTTTCGATTCCAAT
 GAAGCCATGTACACTAAAATCAAGCAGGGCGGAACCACTTACGACATTGCTGTTCTAGTGATTACACCAT
 TGATAAAATGATCAAAGAAAACCTACTCAATAAGCTTGATAAGTCAAAATTAGTTGGCATGGATAATATCG
 GGAAAGAATTTTATAGGGAAAAGCTTTGACCCACAAAACGACTATTCTTTGCCTTATTTCTGGGGAACCGTT
 GGGATTGTTTATAATGATCAATTAGTTGATAAGGCGCCTATGCACTGGGAAGATCTGTGGCGTCCAGAATA
 TAAAAATAGTATTATGCTGATTGATGGAGCGCGTGAAATGCTAGGGGTTGGTTTAACAACCTTTTGTTATA
 GTGTGAATTCTAAAAATCTAGAGCAGTTGCAGGCAGCCGAGAGAAAACCTGCAGCAGTTGACGCCGAATGTT
 AAAGCCATTGTAGCAGATGAGATGAAAGGCTACATGATTCAAGGTGACGCTGCTATTGGAATTACCTTTTC
 TGGTGAAGCCAGTGAGATGTTAGATAGTAACGAACACCTTCACTACATCGTGCCTTCAGAAGGGTCTAACC
 TTTGGTTTGATAATTTGGTACTACCAAAAACCATGAAACACGAAAAAGAAGCTTATGCTTTTTTTGAACTTT
 ATCAATCGTCCTGAAAATGCTGCGCAAAATGCTGCATATATTGGTTATGCGACACCAAATAAAAAAGCCAA
 GGCCTTACTTCCAGATGAGATAAAAAATGATCCTGCTTTTTATCCAACAGATGACATTATCAAAAAATTGG
 AAGTTTATGACAATTTAGGGTCAAGATGGTTGGGGATTATAATGATTATACCTCCAATTTAAATGTAT
 CGCAAATAA

SEQ ID NO: 63 amino acid sequence comprising N-terminal leader sequence of GAS 159
 MRKLYSFLAGVLGVIVILTSLSFI

SEQ ID NO: 64 amino acid sequence comprising a fragment of GAS 159 where the N-terminal
 leader sequence is removed

LQKKSGSGSQSDKLVIYNWGDYIDPALLKKFTKETGIEVQYETFDSEAMYTKIKQGGTTYDIAVPSDYTI
 DKMIKENLLNKLDKSKLVGMDNIGKEFLGKSFDPPQNDYSLPYFWGTVGIVYNDQLVDKAPMHWEDLWRPEY
 KNSIMLIDGAREMLGVGLTTFGYSVNSKNLEQLQAAERKLQQLTPNVKAIVADEMKGMYIQGDAAIGITFS
 GEASEMLDSNEHLHYIVPSEGSNLWFDNLVLPKTMKHEKEAYAFNFINRPENAAQNAAYIGYATPNKKAK
 ALLPDEIKNDPAFYPTDDI IKKLEVYDNLGSRWLGIYNDLYLQFKMYRK

SEQ ID NO: 65 amino acid sequence comprising C-terminal hydrophobic sequence of GAS 159
 WLGIYNDLYLQFKMYRK

SEQ ID NO: 66 amino acid sequence comprising a fragment of GAS 159 where the C-terminal
 hydrophobic region is removed

MRKLYSFLAGVLGVIVILTSLSFILQKKSGSGSQSDKLVIYNWGDYIDPALLKKFTKETGIEVQYETFDSE
 EAMYTKIKQGGTTYDIAVPSDYTIDKMIKENLLNKLDKSKLVGMDNIGKEFLGKSFDPPQNDYSLPYFWGTV
 GIVYNDQLVDKAPMHWEDLWRPEYKNSIMLIDGAREMLGVGLTTFGYSVNSKNLEQLQAAERKLQQLTPNV
 KAIVADEMKGMYIQGDAAIGITFSGEASEMLDSNEHLHYIVPSEGSNLWFDNLVLPKTMKHEKEAYAFNFIN
 INRPENAAQNAAYIGYATPNKKAKALLPDEIKNDPAFYPTDDI IKKLEVYDNLGSR

SEQ ID NO: 67 amino acid sequence comprising a fragment of GAS 159 where the N-terminal
 leader sequence and the C-terminal hydrophobic region is removed

LQKKSGSGSQSDKLVIYNWGDYIDPALLKKFTKETGIEVQYETFDSEAMYTKIKQGGTTYDIAVPSDYTI
 DKMIKENLLNKLDKSKLVGMDNIGKEFLGKSFDPPQNDYSLPYFWGTVGIVYNDQLVDKAPMHWEDLWRPEY
 KNSIMLIDGAREMLGVGLTTFGYSVNSKNLEQLQAAERKLQQLTPNVKAIVADEMKGMYIQGDAAIGITFS
 GEASEMLDSNEHLHYIVPSEGSNLWFDNLVLPKTMKHEKEAYAFNFINRPENAAQNAAYIGYATPNKKAK
 ALLPDEIKNDPAFYPTDDI IKKLEVYDNLGSR

SEQ ID NO: 68 amino acid sequence comprising GAS 217

MAQR IIVITGASGGLAQAIVKQLPKEDSLILLGRNKERLEHCYQHIDNKECLELDITNPVAIEKMVAQIYQ
 RYGRIDVLINNAGYGAFKGFEEFSAQEIADMFQVNTLASIHFACLIGQKMAEQGQGH LINIVSMAGLIASA
 KSSIYSATKFALIGFSNALRLELADKGVYVTTVNP GP IATKFFDQADPSGHYLESVGKFTLQPNQVAKRLV
 SIIGKNKRELNL PFS LAVTHQFYTLFPKLS DY LARKVFNYK

SEQ ID NO: 69 polynucleotide sequence encoding GAS 217

SEQUENCE LISTING

ATGGCACAAAGAATCATTGTTATCACGGGAGCTTCTGGAGGACTGGCTCAGGCAATTGTTAAGCAGTTACC
 CAAGGAAGACAGCTTGATTTTATTAGGACGTAACAAAGAACGCCTAGAACACTGTTATCAGCATATTGACA
 ACAAAGAATGCCTCGAGTTGGATATTACCAATCCAGTAGCCATTGAGAAAATGGTCGCCCAGATTTACCAG
 CGCTATGGCCGTATTGATGTCTTGATTAATAATGCTGGCTACGGAGCTTTCAAAGGCTTTGAAGAGTTTTC
 TGCCCAAGAAATAGCTGATATGTTTCAGGTTAACACCCTAGCGAGCATTCACTTTGCTTGCTTGATTGGTC
 AGAAAATGGCAGAGCAGGGGCAAGGTCACCTTATTAATATTGTGTCCATGGCAGGCTTGATTGCGTCAGCC
 AAATCGAGCATTTATTTCAGCCACCAAGTTTGCCCTTATCGGATTTTCCAATGCCCTTCGCTTAGAATTAGC
 GGATAAAGGGGTTTACGTGACCACCGTGAATCCAGGTCCCATTTGCCACCAAGTTTTTTTGACCAAGCTGACC
 CGTCTGGACATTATTTGGAAAGCGTTGGTAAATTTACTCTCCAACCAATCAAGTGGCTAAGCGTTTGGTT
 TCTATTATCGGGAAAAATAAACGAGAATTGAATTTGCCCTTTAGTTTAGCGGTGACCCATCAATTTTACAC
 CCTTTTCCCTAAATTATCTGATTATCTTGCAAGAAAGGTATTTAATTATAAATGA

SEQ ID NO: 70 amino acid sequence comprising GAS 309

MIEKYLESSIESKQLIVLFFKTSYLPITEVAEKTGLTFLQLNHYCEELNAFFPGSLSMITIQKRMISCQFT
 HPFKETYLYQLYASSNVLQLLAFLIKNGSHSRPLTDFARSHFLSNSSAYRMREALIPLLRNFELKLSKNKI
 VGEEYRIRYLIALLYSKFGIKVYDLTQQDKNTIHSFLSHSSTHLKTSFPLSESFYDILLALSWKRHQFS
 VTIPQTRIFQQLKLFVYDSLKKSSHDIETCYQLNFSAGDLDYLYLIYITANNSFASLQWTPEHIRQYQC
 LFEENDTFRLLLNPIITLLPNLKEQKASLVKALMFFSKSFLFNLQHFIPETNLFVSPYYKGNQKLYTSLKL
 IVEEWMAKLPKRDNLNKHFLFCHYVEQSLRNIQPLVVVFVASFNAHLLTDSFPRYFSDKSIDFHSY
 YLLQDNVYQIPDLKPDLVITHSQLIPFVHHELTGKIAVAEISFDESILSIQELMYQVKEEFQADLTQOLT

SEQ ID NO: 71 polynucleotide sequence encoding GAS 309

TTGATAGAAAAATACTTGGAATCATCAATCGAATCAAAATGTCAGTTAATTGTCTTGTTTTTTAAGACATC
 TTATTTGCCAATAACTGAGGTAGCAGAAAAAACTGGCTTAACCTTTTTTACAACCTAAACCATTATTGTGAGG
 AACTGAATGCCTTTTTCCCTGGTAGTCTGTCTATGACCATCCAAAAAAGGATGATATCTTGCCAATTTACA
 CATCCTTTTAAAGAACTTATCTTTACCAACTCTATGCATCATCTAATGTCTTACAATTACTAGCCTTTTT
 AATAAAAAATGGTTCCCACTCTCGTCCCTTACGGATTTTGCAAGAAGTCATTTTTTATCAAACCTCCTCAG
 CTTATCGGATGCGCGAAGCATTGATTCCTTTATTAAGAACTTTGAATTAATAACTCTCTAAGAACAAGATT
 GTCGGTGAGGAATATCGCATCCGTACCTCATCGCTCTGCTATATAGTAAGTTTGGCATTAAGTTTATGA
 CTTGACGCAGCAAGACAAAAACACTATTCATAGCTTTTTTATCCCATAGTTCCACCCACCTTAAACCTCTC
 CTTGGTTATCGGAATCGTTTTCTTTCTATGACATTTTATTAGCTTTATCGTGGAAGCGGCATCAATTTTCG
 GTAACCTATTTCCCAAACCAGAATTTTTCAACAATTAAAAAAACTTTTTGTCTACGATTCTTTGAAAAAAG
 TAGCCATGATATTATCGAACTTACTGCCAACTAACTTTTCAGCAGGAGATTTGGACTACCTCTATTTAA
 TTTATATCACCGCTAATAATTCTTTTGCGAGCTTACAATGGACACCTGAGCATATCAGACAATATTGTCAA
 CTTTTTGAAGAAATGATACTTTTCGCCTGCTTTTAAATCCTATCATCACTCTTTTACCTAACCTAAAAGA
 GCAAAAGGCTAGTTTAGTAAAAGCTCTTATGTTTTTTTCAAAATCATTCTTGTTTAACTTGCAACATTTTA
 TTCCTGAGACCAACTTATTCGTTTTCTCCGTACTATAAAGGAAACCAAAAACCTCTATACGTCCTTAAAGTTA
 ATTGTGCAAGAGTGGATGGCCAACTTCTTGGTAAGCGTGACTTGAACCATAAGCATTTTCATCTTTTTTG
 CCACTATGTGCGAGCAAAGTCTAAGAAATATCCAACCTCCTTTAGTTGTTGTTTTCGTAGCCAGTAATTTTA
 TCAATGCTCATCTCCTAACGGATTCTTTTCCAAGGTATTTCTCGGATAAAAGCATTTGATTTTCATTCCTAT
 TATCTATTGCAAGATAATGTTTATCAAATTCCTGATTTAAAGCCAGATTTGGTCATCACTCACAGTCAACT
 GATTCCTTTTGTTCACCATGAACCTTACAAAAGGAATTGCTGTTGCTGAAATATCTTTTGATGAATCGATTC
 TGTCTATCCAAGAATTGATGTATCAAGTTAAAGAGGAAAAATCCAAGCTGATTTAACCAAGCAATTAACA
 TAA

SEQ ID NO: 72 amino acid sequence comprising GAS 372

MIQIGKLFAGRYRILKSIGRGMADVYLANDLILDNEDVAIKVLRNTNYQTDQVAVARFQREARAMAELNHP
 NIVAIRDIGEEDGQQFLVMEYVDGADLKRYIQNHAPLSNNEVVRIMEEVL SAMTLAHQKGIVHRDLKPQNI
 LLTKEGVVKVTDGFI AVAFAETSLTQTN SMLGSVHYLSPEQARGSKATI QSDIYAMGIMLFEMLTGHI PYD
 GDSAVTIALQHFQKPLPSII EENHNVPQALENVVIRATAKKLS DRYGSTFEMS RDLMTALS YNRSRERKII
 FENVESTKPLPKVASGPTASVKLS PPTPTVLTQESRLDQTNQTDALQPPTKKKSGRFLGTLFKILFSFFI
 VGVALFTYLILTKPTSVKVPNVAGTSLKVAKQELYDVGLKVGKIRQIESDTVAEGNVVRTPDKAGTAKRQG
 SSITLYV SIGNKGFDMENYKGLDYQEAMNSLIETYGVPKSKIKIERIVTNEY PENTVISQSPSAGDKFNPN
 GKSKITLSVAVSDTITMPMVTEYSYADAVNTLTALGIDASRIKAYVPSSSSATGFVPIHSPSSKAIVSGQS
 PYYGTSLSLSDKGEISLYLYPEETHSSSSSSSSSTSSSNSSSINDSTAPGSNTELSPSETTSQTP

SEQUENCE LISTING

SEQ ID NO: 73 polynucleotide sequence encoding GAS 372

ATGATTTCAGATTGGCAAATTATTTGCTGGTCGTTATCGCATTCTGAAATCTATTGGCCGCGGTGGTATGGC
GGATGTTTATTTAGCAAATGACTTGATCTTGGATAATGAAGACGTTGCAATCAAGGTCTTGCGTACCAATT
ATCAAACAGATCAGGTAGCAGTTGCGCGTTTCCAACGAGAAGCGCGGGCCATGGCTGAATTGAACCATCCC
AATATTGTTGCCATCCGGGATATAGGTGAAGAAGACGGACAGCAATTTTATAGTAATGGAATATGTGGATGG
TGCTGACCTAAAGAGATACATTCAAAATCATGCTCCATTATCTAATAATGAAGTGGTTAGAATTATGGAAG
AAGTCCTTTCTGCTATGACTTTAGCCCACCAAAAAGGAATTGTACACAGAGATTTAAAACCTCAAAATATC
CTACTAACTAAGGAGGGTGTGTCAAAGTAACTGATTTTCGGCATCGCAGTAGCCTTTGCAGAAACAAGCTT
GACACAAACTAATTCGATGTTAGGCAGTGTTCATTACTTGTCTCCAGAACAGGCTCGCGGCTCCAAAGCGA
CGATTCAAAGTGATATTTATGCGATGGGGATTATGCTCTTTGAGATGTTGACAGGCCATATCCCTTATGAC
GGCGATAGTGCTGTTACGATTGCCTTGCAACATTTTCAAAGCCTCTTCCATCTATTATCGAGGAGAACCA
CAATGTGCCACAAGCTTTGGAGAATGTTGTTATTCGAGCAACAGCCAAGAAATTAAGTGATCGTTACGGGT
CAACCTTTGAAATGAGTCGTGACTTAATGACGGCGCTTAGTTATAATCGTAGTCGGGAGCGTAAGATTATC
TTTGAGAAATGTTGAAAGTACCAAACCCCTCCCCAAAGTGGCCTCAGGTCCCACCGCTTCTGTAAATTTGTC
TCCCCCTACCCCAACAGTGTTAACACAGGAAAGTCGATTAGATCAAATAATCAAACAGATGCTTTACAGC
CCCCACCAAAAAGAAAAAAGTGGTCGTTTTTTAGGTACTTTATTCAAAATTCTTTTTTCTTTCTTTATT
GTAGGTGTAGCACTCTTTACTTATCTTATACTAACTAAACCAACTTCTGTGAAAGTTCCTAATGTAGCAGG
CACTAGTCTTAAAGTTGCCAAACAAGAACTGTATGATGTTGGGCTAAAAGTGGGTAAAATCAGGCAAATTG
AGAGTGATACGGTTGCTGAGGGAAATGTAGTTAGAACAGATCCTAAAGCAGGAACAGCTAAGAGGCAAGGC
TCAAGCATTACGCTTTATGTGTCAATTGGAAACAAGGTTTTGACATGGAAAACCTACAAAGGACTAGATTA
TCAAGAAGCTATGAATAGTTTGATAGAACTTATGGTGTTCCAAAATCAAAAATCAAAATTGAGCGCATTG
TAACTAATGAATATCCTGAAAATACAGTCATCAGTCAATCGCCAAGTGCGGGTGATAAATTTAATCCAAAC
GGAAAGTCTAAAATTACGCTCAGTGTTGCTGTTAGTGATACGATCACTATGCCTATGGTAACAGAATATAG
TTATGCAGATGCAGTCAATACCTTAACAGCTTTAGGTATAGATGCATCTAGAATAAAAGCTTATGTGCCAA
GCTCTAGCTCAGCAACGGGCTTTGTGCCAATTCATTCCTAGTTCTAAAGCTATTGTCAGTGGTCAATCT
CCTTACTATGGAACGTCTTTGAGTCTGTCTGATAAAGGAGAGATTAGTCTTTACCTTTATCCAGAAGAAAC
ACACTCTTCTAGTAGCTCATCGAGTTCAACGTCAAGTTCAAACAGTTCTTCAATAAATGATAGTACTGCAC
CAGGTAGCAACACTGAATTAAGCCCATCAGAACTACTTCTCAAACACCTTAA

SEQ ID NO: 74 amino acid sequence comprising GAS 39

MDLILFLLVLVLLGLGAYLLFKVNGLOHQLAQTLEGNADNLSQMTYQLDTANKQQLLELTQLMNRQQAGL
YQQLTDIRDVLHRSLSDSRDRSDKRLEKINQQVNQSLKNMQESNEKRLEKMRQIVEEKL EETLKNRNLHASF
DSVSKQLESVNKGLGEMRSVAQDVGTLNKLVSNTKTRGILGELQLGQI IEDIMTSSQYEREFVTVSGSSER
VEYAIKLPNGQGQGYIYLPIDSKFPLEDYRLEDAYEVGDKLAI EASRKALLAAIKRFAKDIHKKYLNPPPE
TTNFGVMFLPTEGLYSEVVRNASFFDSLREENIVVAGPSTLSALLNSLSVGFKTLNIQKNADDISKILGN
VKLEFDKFGGLLAKAQKQMNTANNTLDQLISTRINAIVRALNTVETYQDQATKSLNLMPLLEEENNEN

SEQ ID NO: 75 polynucleotide sequence encoding GAS 39

ATGGACCTTATCTTGTTCCTTTTGGTCTTGGTCTCTTAGGTTTAGGGGCTTATCTGTTGTTCAAAGTCAA
CGGCCTTCAACATCAGCTTGCCCAAACCTAGAAAGGCAACGCGGATAATTTGTCTGACCAAATGACCTACC
AGTTGGATACAGCTAACAAACAACAATTGTTAGAGCTAACACAGCTGATGAACCGACAACAAGCAGGCCTT
TACCAACAATTAACAGATATTCGTGACGTCTTGACCCGTAGTTTGTCTGATAGTAGGGACCGGTCTGACAA
ACGCTTAGAAAAAATTAACCAGCAGGTCAACCAATCGCTCAAAAATATGCAAGAATCTAACGAAAAACGTT
TGAGAGAAAATGCGCCAGATCGTTGAAGAAAAATTGGAAGAAACCTTAAAAAATCGTCTGCACGCCTCTTTC
GATTCTGTATCCAAGCAACTAGAAAGTGTCATAAAGGCTTGGGAGAAATGCGTAGCGTGGCTCAAGATGT
GGGTACTTTAAATAAGGTTTTGTCCAATACCAAAACACGAGGCATTTTAGGCGAACTTCAACTAGGCCAAA
TCATTGAGGATATCATGACATCAAGCCAGTACGAAAGAGAATTTGTAACGGTTAGTGGTTCTAGTGAACGC
GTAGAATATGCGATTAAGCTCCCAGGAAATGGTCAAGGCGGTTATATTTACCTACCGATTGACTCAAAATT
CCCTCTTGAAGATTATTACCGATTAGAAGATGCTTACGAAGTTGGTGATAAACTGGCCATCGAGGCTAGCC
GAAAAGCACTTCTGGCAGCTATCAAACGCTTTGCCAAAGACATTCATAAAAAGTACTTGAACCCCCCAGAG
ACGACCAATTTCCGGAGTTATGTTCTTACCAACAGAAGGTCTTTATTCAAGAGTGGTCAGAAATGCGTCTTT
CTTTGATAGCCTTCGTGCGGAAGAAAATATTGTGGTTGCAGGCCCTTCGACCCTGTCTGCTTTGCTGAATT
CCTTATCTGTTGGTTTCAAGACCCTTAATATCCAAAAAATGCTGATGACATCAGTAAATTTTAGGCAAT
GTCAAGTTAGAATTCGATAAATTTGGCGGCCTGCTTGCCAAGGCTCAAAAACAAATGAATACAGCTAATAA
TACGCTGGATCAGCTCATTTCAACAAGGACAAATGCCATTGTTTCGAGCCTTGAATACCGTTGAACTTATC
AAGACCAAGCAACAAAATCTCTCTTGAACATGCCCTTATTAGAAGAGGAAAATAATGAAAATTAA

SEQUENCE LISTING

SEQ ID NO: 76 amino acid sequence comprising GAS 42

MTKEKLVAFSQAHAEPAWLQERRLAALAEIAPNLELPTIERVKFHRWNLGDGTLTENESLASVPDFIAIGDN
 PKLVQVGTQTVLEQLPMALIDKGVVFSDFYTALEEIPEVIEAHFGQALAFDEDEKLAAYHTAYFNNSAAVLYV
 PDHLEITTPIEAIFLQSDSDVPFNKHVLVIAGKESKFTYLERFESIGNATQKISANISVEVIAQAGSQIK
 FSAIDRLGPSVTITYISRRGRLEKDANIDWALAVMNEGNVIADFDSDLIGQGSQADLKVVAASSGRQVQID
 TRVTNYGQRTVGHILQHGVLERGTLTFTNGIGHILKDAKGADAQQESRVLMLSDQARADANPILLIDENEV
 TAGHAASIGQVDPEDMYLMSRGLDQETAERLVIRGFLGAVIAEIPISVRQEIIKVLDEKLLNR

SEQ ID NO: 77 polynucleotide sequence encoding GAS 42

ATGACAAAAGAAAACTAGTGGCTTTTTCGCAAGCCCACGCTGAGCCTGCTTGGCTGCAAGAACGGCGTTT
 AGCGGCATTAGAAGCCATTCCAAATTTGGAATTACCAACCATCGAAAGGGTTAAATTTCAACCGTTGGAATC
 TAGGAGATGGTACCTTAACAGAAAATGAAAGTCTAGCTAGTGTTCAGATTTTATAGCTATTGGAGATAAC
 CCAAAGCTTGTTTCAGGTAGGCACGCAAACAGTCTTAGAACAGTTACCAATGGCGTTAATTGACAAGGGAGT
 TGTTTTTCAGTGATTTTATACGGCGCTTGAGGAAATCCCAGAAGTAATTGAAGCTCATTTTGGTCAGGCAT
 TAGCTTTTGATGAAGACAACTAGCTGCCTACCACACTGCTTATTTTAATAGCGCAGCCGTGCTCTACGTT
 CCTGATCACTTGGAATCACAACTCCTATTGAAGCTATTTTCTTACAAGATAGTGACAGTGACGTTCTCTT
 TAACAAGCATGTTCTAGTGATTGCAGGAAAAGAAAGTAAGTTCACCTATTTAGAGCGTTTTGAATCTATTG
 GCAATGCCACTCAAAGATCAGCGCTAATATCAGTGTAGAAGTGATTGCTCAAGCAGGCAGCCAGATTAA
 TTCTCGGCTATCGACCGCTTAGGTCCTTCAGTGACAACCTATATTAGCCGTCGAGGACGTTTAGAGAAGGA
 TGCCAACATTGATTGGGCCTTAGCTGTGATGAATGAAGGCAATGTCATTGCTGATTTTGACAGTGATTGGA
 TTGGTCAGGGCTCACAAGCTGATTTGAAAGTTGTTGCAGCCTCAAGTGGTCGTCAGGTACAAGGTATTGAC
 ACGCGCGTGACCAACTATGGTCAACGTACGGTCGGTCATATTTTACAGCATGGTGTGATTTTGGAACGTGG
 CACCTTAACGTTTAACGGGATTGGTCATATTTCTAAAGACGCTAAGGGAGCTGATGCTCAACAAGAAAGCC
 GTGTTTTGATGCTTTCTGACCAAGCAAGAGCCGATGCCAATCCAATCCTCTTAATTGATGAAAATGAAGTA
 ACAGCAGGTCATGCAGCTTCTATCGGTCAGGTTGACCCTGAAGATATGTATTACTTGATGAGTCGAGGACT
 GGATCAAGAAACAGCAGAACGATTGGTTATTAGAGGATTCCTAGGAGCGGTTATCGCTGAAATTCCTATTC
 CATCAGTCCGCCAAGAGATTATTAAGGTTTTAGATGAGAAATTGCTTAATCGTTAA

SEQ ID NO: 78 amino acid sequence comprising GAS 58

MKWSGFMKTKSKRFLNLATLCLALLGTTLLMAHPVQAEVISKRDYMTRFGLGDLEDDSANYPNLEARYKG
 YLEGYEKGLKGDDIPERPKIQVPEDVQPSDHG DYRDGYEEGFEGQHKRDPLETEAEDDSQGGRQEGRQGH
 QEGADSSDLNVEESDGLSVIDEVGVIIYQAFSTIWTYLSGLF

SEQ ID NO: 79 polynucleotide sequence encoding GAS 58

ATGAAATGGAGTGGTTTTATGAAAACAAAATCAAACGCTTTTTAAACCTAGCAACCCTTTGCTTGGCCCT
ACTAGGAACAACCTTTGCTAATGGCACATCCCGTACAGGCGGAGGTGATATCAAAAAGAGACTATATGACTC
 GCTTCGGGTTAGGCGATTTAGAAGATGATTCAGCTAACTATCCTTCAAATTTAGAAGCTAGATATAAAGGA
 TATTTAGAGGGATATGAAAAGGCTTAAAGGAGATGATATACCCGAACGGCCCAAGATTCAGGTTCTTGA
 GGATGTTTCAGCCATCTGACCATGGCGACTATAGAGATGGTTATGAGGAAGGATTTGGAGAAGGACAACATA
 AACGTGATCCATTAGAAACAGAAGCAGAAGATGATTCCTCAAGGAGGACGTCAAGAAGGACGTCAAGGACAT
 CAAGAAGGAGCAGATTCTAGTGATTTGAACGTTGAAGAAAGCGACGGTTTGTCTGTTATTGATGAAGTAGT
 TGGAGTAATTTATCAAGCATTTAGTACTATTTGGACATACTTAAGCGGTTTGTCTAA

SEQ ID NO: 80 amino acid sequence comprising N-terminal leader sequence of GAS 58

MKWSGFMKTKSKRFLNLATLCLALLGTTLLMA

SEQ ID NO: 81 amino acid sequence comprising a fragment of GAS 58 where the N-terminal leader sequence is removed

HPVQAEVISKRDYMTRFGLGDLEDDSANYPNLEARYKGYLEGYEKGLKGDDIPERPKIQVPEDVQPSDHG
 DYRDGYEEGFEGQHKRDPLETEAEDDSQGGRQEGRQGHQEGADSSDLNVEESDGLSVIDEVGVIIYQAFS
 TIWTYLSGLF

SEQ ID NO: 82 amino acid sequence comprising GAS 290

SEQUENCE LISTING

MKHILFIVGSLREGSFNHLAAQAQKALEHQAVVSYLNWKDVPVLNQDIEANAPLPVVDARQAVQSADAIW
 IFTPVYNFSIPGSVKNLLDWLSRALDLSIPTGSAIGGKVTVSSVANGGHDQVFDQFKALLPFIRTSVAG
 EFTKATVNPDAWGTGRLEISKETKANLLSQAEALLAAI

SEQ ID NO: 83 polynucleotide sequence encoding GAS 290

ATGAAACATATTTTATTATTGTTGGCTCGCTTCGTGAAGGGTCTTTTAACCATCAATTAGCGGCTCAAGC
 ACAAAAAGCTCTGGAACATCAAGCAGTTGTATCTTACTTAAATTGGAAAGACGTTCTGTTTTGAATCAAG
 ATATCGAAGCTAATGCACCTTTACCAGTTGTTGACGCTCGTCAAGCTGTTTCAGTCAGCGGATGCTATCTGG
 ATTTTACACCAGTTTACAACCTTCTCTATTCCAGGTTCTGTAAAAACCTGCTAGACTGGTTGTCTCGTGC
 TCTTGATTTGTCTGATCCGACGGGCCCATCTGCTATTGGCGGTAAGGTGGTTACGGTCTCTTCAGTTGCAA
 ATGGCGGGCATGATCAAGTATTTGATCAGTTTAAAGCACTATTGCCGTTTATCCGAACCTCAGTAGCAGGA
 GAGTTTACAAAAGCAACTGTGAATCCTGATGCCTGGGGAACAGGAAGGCTTGAGATTTCAAAAGAGACAAA
 AGCAAACTTGCTATCTCAGGCAGAGGCTCTTTTAGCGGCTATTTAG

SEQ ID NO: 84 amino acid sequence comprising GAS 511

MTDVSRLKEARDQGRLTTLDYANLIFDDFMELHGDRHFSDDGAIVGGLAYLAGQPVTVIGIQKGKNLQDN
 LARNFGQPNPEGYRKALRLMKQAEKFGRPVVTFFINTAGAYPGVGAEERGQGEAIAKNLMEMSDLKVPIIAI
 IIGEGSGGALALAVADQVWMLENTMYAVLSPEGFASILWKDGSRATEAAELMKITAGELYKMGIVDRIIP
 EHGYSSEIVDIIKANLIEQITSLQAKPLDQLLDERYQRFKY

SEQ ID NO: 85 polynucleotide sequence encoding GAS 511

ATGACAGATGTATCAAGAATTTTAAAAGAAGCGCGTGATCAAGGGCGTTTAAACAACCTTGGATTACGCCAA
 CCTTATTTTCGATGACTTTATGGAAGTGCATGGCGATCGCCATTTTTCAGATGATGGTGCCATTGTAGGTG
 GCCTAGCTTATTTGGCGGGACAACCTGTTACGGTCATTGGTATTTCAAAAAGGTAAGAATTTACAGGATAAT
 TTGGCAAGGAATTTTGGCCAGCCCAATCCAGAAGGTTATCGTAAAGCTTTGCGCCTTATGAAACAGGCAGA
 AAAATTTGGACGACCAGTTGTTACGTTTATCAATACTGCAGGAGCCTATCCAGGTGTCGGTGCGGAAGAAC
 GAGGACAGGGTGAGGCCATTGCTAAAAATTTGATGGAAATGAGTGATCTCAAGGTTCCCATTTATCGCCATC
 ATTATTGGTGAAGGAGGCTCTGGTGGTGCATTAGCCTTAGCGGTTGCCGATCAGGTCTGGATGCTTGAAAA
 TACTATGTATGCGGTTCTTAGCCCAGAAGGCTTTGCTTCTATTTTATGGAAGGATGGTTCAAGGGCGACCG
 AGGCCGCTGAATTGATGAAAATCACAGCGGGTGAAGTCTACAAAATGGGAATAGTAGACCGTATTATTCCA
 GAACATGGTTATTTTCAAGTGAAATCGTTGACATCATCAAAGCTAACCTCATCGAACAAATAACCAAGTTT
 GCAAGCTAAGCCATTAGACCAATTATTAGATGAGCGCTACCAACGCTTTTCGTAAATATTAA

SEQ ID NO: 86 amino acid sequence comprising GAS 533

MAITVADIRREVKEKNVTFLRLMFTDIMGVMKNVEIPATKEQLDKVLSNKVMFDGSSIEGFVRINESDMYL
 YPDLDTWIVFPWGDENGAVAGLICDIYTAEGKPFAGDPRGNLKRALKHMNEIGYKSFNLGPEPEFFLFKMD
 DKGNPTLEVNDNGGYFDLAPIDLADNTRREIVNILTGMGFVEEASHHEVAVGQHEIDFKYADVLKACDNIQ
 IFKLVVKTIAREHGLYATFMAKPKFGIAGSGMHCMNSLFDNQNNAFYDEADKRGMLSEDAYYFLGGLMK
 HAYNYTAITNPTVNSYKRLVPGYEAPVYVAVAGSNRSPLIRVPASRGMGTRLELRSDPTANPYLALAVLL
 EAGLDGIINKIEAPEPVEANIYTMTEERNEAGIIDLPSTLHNALKALQKDDVVQKALGYHIYTNFLEAKR
 IEWSSYATFVSQWEIDHYIHNY

SEQ ID NO: 87 polynucleotide sequence encoding GAS 533

ATGGCAATAACAGTAGCTGACATTCGTCTGAAGTCAAAGAAAAAATGTAACGTTTCTTCGCTTGATGTT
 CACTGATATCATGGGCGTTATGAAAAATGTGGAGATTCCTGCAACTAAAGAACAGTTAGACAAAGTATTGT
 CTAACAAGGTTATGTTTGATGGTTCATCTATCGAAGGTTTGTACGGATCAATGAGTCAGATATGTACCTT
 TACCCCGATTTAGACACTTGGATTGTTTTTCCCTGGGGAGATGAAAATGGAGCAGTTGCAGGTTTAATTTG
 TGATATTTATACAGCAGAAGGAAAGCCTTTTGCAGGAGATCCTAGAGGAAATTTAAAAAGAGCCCTGAAAC
 ACATGAACGAGATCGGCTACAAATCATTTAATCTTGGACCAGAACCAGAATTTTTCCTTTTAAAGATGGAT
 GATAAAGGTAATCCGACACTTGAAGTTAACGATAATGGTGGTTATTTTGATTTAGCGCCAATTGACTTAGC
 AGACAACACGCGCCGTGAAATTGTGAATATTTTAAACGAAAATGGGTTTGAAGTGGAAGCTAGTCATCATG
 AAGTGGCTGTTGGTCAACATGAGATTGATTTTAAATATGCAGATGTTTTGAAAGCTTGTGATAATATTCAA
 ATTTTAAAGCTAGTTGTAAAAACGATTGCCCGTGAACATGGACTTTATGCTACTTTCATGGCTAAACCAA
 ATTTGGAATAGCTGGATCAGGGATGCACTGTAACATGTCTTTGTTTGATAACCAAGGTAATAATGCTTTT
 ATGATGAAGCTGATAAGCGAGGGATGCAGTTATCAGAAGATGCTTATTATTTCTTGGGAGGACTAATGAAG
 CATGCTTATAACTACACTGCTATCACTAACCTACAGTGAATCTTATAAACGATTAGTTCCAGGTTATGA

SEQUENCE LISTING

GGCACCTGTTTATGTCGCTTGGGCTGGAAGTAATCGTTCACCGCTTATCCGTGTTCCAGCATCACGTGGTA
TGGGAACGCGTTTGGAGTTACGTTCCGTTGATCCGACAGCTAATCCTTATTTAGCCTTGGCTGTTCTCTTG
GAAGCTGGATTAGATGGTATCATTAACAAAATTGAAGCTCCAGAACCCGTTGAAGCTAACATTTATACCAT
GACAATGGAAGAACGAAATGAAGCAGGCATTATTGATTTGCCATCAACGCTTCATAATGCCTTAAAAGCTC
TTCAAAAAGATGATGTGGTACAAAAGGCAC TAGGTTACCATATCTACACTAATTTCTTAGAAGCAAAACGA
ATTGAATGGTCTTCTATGCAACTTTTGTTCCTCAATGGGAAATTGACCATTATATTCATAATTATTAG

SEQ ID NO: 88 amino acid sequence comprising GAS 527

MTEISILNDVQKIIIVLDYGSQYNQLIARRIREFGVFSSELKSHKITAQELREINPIGIVLSGGPNSVYADNA
FGIDPEIFELGIPILGICYGMQLITHKLGGKVVPAGQAGNREYQSTLHLRETSKLFSGTPQEQVLMSHG
DAVTEIPEGFHLVGDSNDCPYAAIENTEKNLYGIQFHPVRHSVYVNDILKNFAISICGARGDWSMDNFID
MEIAKIRETVGDRKVLLGLSGGVDSSVVGVLQKAIGDQLTCIFVDHGLLRKDEGDQVMGMLGGKFGLNII
RVDASKRFLDLLADVEDPEKKRKIIIGNEFVYVFDDEASKLKGVDFLAQGTLYTDIIESGTETAQTIKSHHN
VGGLPEDMQFELIEPLNTLFKDEVRLGIALGMPEEIVWRQFPFPGPLAIRVMGAITEEKLETVRES DAIL
REEIAKAGLDRDVWQYFTVNTGVR SVGVMDGR TYDYTIAIRAITSIDGMTADFAQLPVDVLKKISTRIVN
EVDHVNRIYDITSKPPATVEWE

SEQ ID NO: 89 polynucleotide sequence encoding GAS 527

ATGACTGAAATTTCAATTTTGAATGATGTTCAAAAATTTATCGTTCTTGATTATGGTAGCCAGTACAATCA
GCTTATTGCTAGACGTATTCGAGAGTTTGGTGTCTTCTCCGAATAAAAAGCCATAAAATCACCGCTCAAG
AACTTCGTGAGATCAATCCCATAGGTATCGTTTATCAGGAGGGCCTAACTCTGTTTACGCTGATAACGCC
TTTGGCATTGACCCTGAAATCTTTGAACTAGGGATTCCGATTCTTGGTATCTGTTACGGTATGCAATTAAT
CACCCATAAATTAGGTGGTAAAGTTGTTCTTGCTGGACAAGCTGGTAATCGTGAATACGGTCAGTCAACCC
TTCATCTTCGTGAAACGTCAAAATTATTTTCAGGCACACCTCAAGAACAACCTCGTTTGTATGAGCCATGGT
GATGCTGTTACTGAAATTCAGAAAGTTTCCACCTTGTGGAGACTCAAATGACTGTCCCTATGCAGCTAT
TGAAAATACTGAGAAAAACCTTTACGGTATTCAGTTCACCCAGAAGTGAGACACTCTGTTTATGGAAATG
ACATTCTTAAAAACTTTGCTATATCAATTTGTGGCGCGCGTGGTGATTGGTCAATGGATAATTTTATTGAC
ATGGAAATTGCTAAAATTCGTGAAACTGTAGGCGATCGTAAAGTTCTTCTAGGTCTTCTGGTGGAGTTGA
TTCTTCAGTTGTTGGTGTCTACTTCAAAAAGCTATCGGTGACCAATTAACCTTGTATTTTCGTTGATCAG
GTCTTCTTCGTAAAGACGAGGGCGATCAAGTTATGGGAATGCTTGGGGGCAAATTTGGCCTAAATATTATC
CGTGTGGATGCTTCAAAACGTTTCTTAGACCTTCTTGCAGACGTTGAAGATCCTGAGAAAAAACGTAAAT
TATTGGTAATGAATTTGTCTATGTTTGTGATGATGAAGCCAGCAAATTAAGGTGTTGACTTCCTTGCCC
AAGGAACACTTTTATACTGATATCATTTGAGTCAGGAACAGAACTGCTCAAACCATCAAATCACATCACAAT
GTGGGTGGTCTCCCCGAAGACATGCAGTTTGAATTGATTGAGCCCTTAAACACTCTTTTCAAAGATGAAGT
TCGAGCGCTTGAATCGCTCTTGAATGCCTGAAGAAATTGTTTGGCGCCAACCATTTCCAGGTCCTGGAC
TTGCTATCCGTGTCATGGGAGCAATTACTGAAGAAAACTTGAAACCGTTCGCGAATCAGACGCTATCCTT
CGTGAAGAAATTGCTAAGGCTGGACTTGATCGTGACGTGTGGCAATACTTTACAGTTAACACAGGTGTCCG
TTCTGTAGGCGTCATGGGAGATGGTTCGTAATTATGATTATACCATCGCCATTCTGTGCTATTACGTCTATTG
ATGGTATGACAGCTGACTTTGCTCAACTTCCTTGGGATGTCTTGAAAAAATCTCAACACGTATCGTAAAT
GAAGTTGACCACGTTAACCGTATCGTCTACGACATCACAAGTAAACCACCCGCAACAGTTGAATGGGAATA
A

SEQ ID NO: 90 amino acid sequence comprising GAS 294

MSQSTATYINVIGAGLAGSEAAYQIAKRGI PVKLYEMRGVKATPQHKTTFNFAELVCSNSFRGDSL TNVAVGL
LKEEMRRLDSIIMRNGEANRVPAGGAMAVDREGYAESVTAELNHPLEIVIRGEITEIPDDAITVIATGPL
TSDALAEKIHALLNGGDGFYFYDAAPIIDKSTIDMSKVYLKSRYDKGEAAYLNC PMTKEEFMAFHEALT
EEAPLNAFEKEKEYFEGCMP IEVMAKRGIKTMLYGPMPKPVGLEYPDDYTGP RDGEFKTPYAVVQLRQDNAAG
SLYNIVGFQTHLKWGEQKRVFQMI PGLENAEFVRYGV MHRNSYMDSPNLLTETFQSRSNPNLFFAGQMTGV
EGYVESAAAGSLVAGINAARL FKREELIFPQTTAIGSLPHYVTHADSKHFQPMNVNFGI I KELEGPRIRDK
KERYEAIASRALADLDTCLASL

SEQ ID NO: 91 polynucleotide sequence encoding GAS 294

TTGTCTCAATCAACTGCAACTTATATTAATGTTATTGGAGCTGGGCTAGCTGGTTC TGAAGCTGCCTATCA
GATTGCTAAGCGCGGTATCCCCGTAAATTGTATGAAATGCGTGGTGTCAAAGCAACACCGCAACATAAAA
CCACTAATTTTGCCGAATTGGTCTGTTCCAACCTCATTTTCGTGGTGATAGCTTAACCAATGCAGTCGGTCTT
CTCAAAGAAGAAATGCGGCGATTAGACTCCATTATTATGCGTAATGGTGAAGCTAACCGCGTACCTGCTGG

SEQUENCE LISTING

GGGAGCAATGGCTGTTGACCGTGAGGGGTATGCAGAGAGTGTCACTGCAGAGTTGGAAAATCATCCTCTCA
 TTGAGGTCATTTCGTGGTGAAATTACAGAAATCCCTGACGATGCTATCACGGTTATCGCGACGGGACCGCTG
 ACTTCGGATGCCCTGGCAGAAAAAATTCACGCGCTAAATGGTGGCGACGGATTCCTATTTTTTACGATGCAGC
 AGCGCCTATCATTGATAAATCTACCATTTGATATGAGCAAGGTTTACCTTAAATCTCGCTACGATAAAGGCG
 AAGCTGCTTACCTCAACTGCCCTATGACCAAAGAAGAATTCATGGCTTTCCATGAAGCTCTGACAACCGCA
 GAAGAAGCCCCGCTGAATGCCCTTTGAAAAAGAAAAGTATTTTGAAGGCTGTATGCCGATTGAAGTTATGGC
 TAAACGTGGCATTAAAACCATGCTTTATGGACCTATGAAACCCGTTGGATTGGAATATCCAGATGACTATA
 CAGGTCCTCGCGATGGAGAATTTAAAACGCCATATGCCGTCGTGCAATTGCGTCAAGATAATGCAGCTGGA
 AGCCTTTTATAATATCGTTGGTTTCCAAACCCATCTCAAATGGGGTGAGCAAAAACGCGTTTTTCCAAATGAT
 TCCAGGGCTTGAAAATGCTGAGTTTGTCCGCTACGGCGTCATGCATCGCAATTCCTATATGGATTACACAA
 ATCTTTTAACCGAAACCTTCCAATCTCGGAGCAATCCAAACCTTTTCTTTGCAGGTCAGATGACTGGAGTT
 GAAGGTTATGTCGAATCAGCTGCTTCAGGTTTAGTAGCAGGAATCAATGCTGCTCGTTTGTTCAAAAGAGA
 AGAAGCACTTATTTTTCTCAGACAACAGCTATTGGGAGTTTGCCTCATTATGTGACTCATGCCGACAGTA
 AGCATTTCCAACCAATGAACGTCAACTTTGGCATCATCAAAGAGTTAGAAGGCCACGCATTCGTGACAAA
 AAAGAACGTTATGAAGCTATTGCTAGTCGTGCTTTGGCAGATTTAGACACCTGCTTAGCGTCGCTTTAA

SEQ ID NO: 92 amino acid sequence comprising GAS 253

MPKKILFTGGGTVGHVTLNLILIPKFIKDGWEVHYIGDKNGIEHTEIEKSGLDVTFHAIATGKLRRYFSWQ
 NLADVFKVALGLLQSLFIVAKLRPQALFSKGGFVSVPPVVAAKLLGKPVFIHESDRSMGLANKIAYKFATT
 MYTTFEQEDQLSKVKHLGAVTKVFKDANQMPESTQLEAVKEYFSRDLKTLFFIGGSAGAHVFNQFISDHPE
 LKQRYNIINITGDPHLNELSSHLRVVDYVTDLYQPLMAMADLVVTRGGSNTLFELLAMAKLHLIVPLGKEA
 SRGDQLENATYFEKRGYAKQLQEPDLTLHNFDQAMADLFEHQADYEATMLATKEIQSPDFFYDLLRADISS
 AIKEK

SEQ ID NO: 93 polynucleotide sequence encoding GAS 253

ATGCCTAAGAAGATTTTATTTACAGGTGGTGGAACGTAGGTCATGTCACCTTGAACCTCATTCTCATACC
 AAAATTTATCAAGGACGGTTGGGAAGTACATTATATTGGTGATAAAAATGGCATTGAACATACAGAAATTG
 AAAAGTCAGGCCTTGACGTGACCTTTTCATGCTATCGCGACAGGCAAGCTTAGACGCTATTTTTTCATGGCAA
 AATCTAGCTGATGTTTTTAAGGTTGCACTTGGCCTCCTACAGTCTCTCTTTATTGTTGCCAAGCTTCGCCC
 TCAAGCCCTTTTTTCCAAAGGTGGTTTTGTCTCAGTACCGCCAGTTGTGGCTGCTAAATTGCTTGGTAAAC
 CAGTCTTTATTCATGAATCAGATCGGTCAATGGGACTAGCAAACAAGATTGCCTACAAATTTGCAACTACC
 ATGTATACCACTTTTGAGCAGGAAGACCAGTTGTCTAAAGTTAAACACCTTGGAGCGGTGACAAAGGTTTT
 CAAAGATGCCAACCACCAATGCCTGAATCAACTCAGTTAGAGGCGGTGAAAGAGTATTTTAGTAGAGACCTAA
 AAACCCTCTTGTTTTATTGGTGGTTCGGCAGGGGCGCATGTGTTTAATCAGTTTATTAGTGATCATCCAGAA
 TTGAAGCAACGTTATAATATCATCAATATTACAGGAGACCCCTCACCTTAATGAATTGAGTTCTCATCTGTA
 TCGAGTAGATTATGTTACCGATCTCTACCAACCTTTGATGGCGATGGCTGACCTTGTAGTGACAAGAGGGG
 GCTCTAATACACTTTTTTGAGCTACTGGCAATGGCTAAGCTACACCTCATCGTTCCCTCTTGGTAAAGAAGCT
 AGCCGTGGCGATCAGTTAGAAAATGCCACTTATTTTGAGAAGAGGGGCTACGCTAAACAATTACAGGAACC
 TGATTTAACTTTGCATAATTTTGATCAGGCAATGGCTGATTTGTTTGAACATCAGGCTGATTATGAGGCTA
 CTATGTTGGCAACTAAGGAGATTCAGTCACCGGACTTCTTTTATGACCTTTTGAGAGCTGATATTAGCTCC
 GCGATTAAGGAGAAGTAA

SEQ ID NO: 94 amino acid sequence comprising GAS 529

MCGIVGVVGNRNATDILMQGLEKLEYRGYDSAGIFVANANQTNLIKSVGRIADLRAKIGIDVAGSTGIGHT
 RWATHGQSTEDNAHPHTSQTGRFVLVHNGVIENYLHIKTEFLAGHDFKQTDTEIAVHLIGKFVEEDKLSV
 LEAFKKSLSIIEGSYAFALMDSQATDTIYVAKNKSPLLIGLGEYNMVCSAMAMIRETSEFMEIHDKELV
 ILTKDKVTVDYDGKELIRDSYTAELDLSDIGKGYPFYMLKEIDEQPTVMRQLISTYADETGNVQVDPAI
 ITSIEADRLYLAAAGTSYHAGFATKNMLEQLTDTPELVASEWGYHMPLLSKKPMFILLSQSGETADSR
 QVLVKANAMGIPSLTVTNVPGSTLSREATYTMLIHAGPEIAVASTKAYTAQIAALAFKAVGEANGKQEA
 LDFNLVHELSSLVAQSIEATLSEKDLVAEKVQALLATTRNAFYIGRGNDYYVAMEAALKLKEISYIQCEGFA
 AGELKHGTISLIEEDTPVIALISSQLVASHTRGNIQEVAARGAHVLTVEEGLDREGDDIIVNKVHPFLA
 PIAMVIPTQLIAYYASLQRLDVKPRNLAKAVTVE

SEQ ID NO: 95 polynucleotide sequence encoding GAS 529

ATGTGTGGAATTGTTGGAGTTGTTGGAAATCGCAATGCAACGGATATTTTAATGCAAGGCCTTGAAAAGCT
 TGAATACCGGGGTTATGATTCAGCAGGAATTTTGTGGCTAATGCCAATCAAACAACTTGATTAAATCAG

SEQUENCE LISTING

TGGGGCGGATTGCTGATTTGCGTGCCAAGATTGGCATTGATGTTGCTGGTTCAACAGGGATTGGTCACACC
 CGTTGGGCAACGCATGGCCAATCAACAGAGGATAATGCCCATCCTCACACGTCACAACTGGACGTTTTGT
 ACTTGTTCATAATGGTGTGATTGAAAATTACCTTCACATTAAACAGAGTTCCTAGCTGGACATGATTTTA
 AGGGGCAGACAGATACTGAGATTGCAGTACACTTGATTGGAAAATTTGTGGAAGAAGACAAGTTGTCAGTA
 CTGGAAGCTTTTAAAAAATCTTTAAGCATTTATTGAAGGTTCTTACGCCCTTTCATTAAATGGATAGCCAAGC
 AACTGATACTATTTATGTGGCTAAAAACAAGTCTCCATTGTTGATTGGACTTGGTGAAGGTTACAACATGG
 TTTGTTTCAGATGCCATGGCCATGATTTCGTGAAACCAGTGAATTTATGGAAATTCATGATAAGGAGCTAGTT
 ATTTTAACCAAAGATAAGGTAAGTGTACAGACTACGATGGTAAAGAGCTGATACGAGATTCCTACACTGC
 TGAATTAGACTTATCTGATATTGGCAAAGGGACTTATCCTTTCTATATGCTGAAAGAAATTGATGAGCAAC
 CAACCGTAATGCGTCAATTAATTTCAACTTATGCAGATGAACTGGTAACGTACAGGTTGATCCGGCTATC
 ATTACCTCTATCCAAGAGGCTGACCGTCTTTATATTTTAGCGGCAGGGACTTCCTACCATGCTGGTTTTGC
 AACAAAAAATATGCTTGAGCAATTGACAGATACACCAGTTGAGTTGGGCGTGGCTTCTGAGTGGGGTTACC
 ACATGCCCTCTGCTTAGCAAGAAACCAATGTTTATTCTACTAAGCCAATCAGGAGAAACCGCAGATAGTCGT
 CAAGTTTGTAGTAAAGGCAAATGCTATGGGCATTCCGAGTTTGACAGTAACTAACGTTCCAGGATCAACCTT
 ATCACGTGAAGCAACATACACCATGTTGATTTCATGCTGGACCTGAAATTGCTGTTGCGTCTACAAAAGCTT
 ACACTGCACAAATTGCTGCCCTTGCCTTTTTGGCTAAGGCAGTTGGTGAGGCAAATGGTAAGCAAGAAGCT
 CTTGACTTTAACTTGGTACATGAGTTGTCATTGGTTGCCCAATCTATTGAGGCGACTTTGTCTGAAAAAGA
 TCTCGTGGCAGAAAAGGTTCAAGCTTTGCTAGCTACTACTCGTAATGCTTTTTTACATCGGGCGTGGCAATG
 ATTATTACGTTGCGATGGAAGCTGCTTTGAAATTAAAGAGATTTCTTATATTCAATGCGAAGGCTTTGCG
 GCTGGTGAATTGAAACATGGAACCATTTCAATTAATTGAGGAGGACACGCCAGTAATCGCTTTAATATCGTC
 TAGTCAGTTGGTTGCCTCTCATACGCGTGGTAATATTCAAGAAGTTGCTGCCCCGTGGGGCTCATGTTTTAA
 CAGTTGTGGAAGAAGGGCTTGACCGTGAGGGAGATGACATTATTGTCAATAAGGTTTCATCCTTTCTAGCC
 CCGATTGCTATGGTTCATTCCAACCTCAACTGATTGCTTACTACGCTTCATTACAACGTGGACTTGATGTTGA
 TAAGCCACGTAATTTGGCTAAAGCTGTAACAGTAGAATAA

SEQ ID NO: 96 amino acid sequence comprising GAS 45

VTFMKKSKWLAAVSVAILSVSALAACGNKNASGGSEATKTYKYVFVNDPKSLDYILTNNGGTTDVITQMVD
 GLENDHEYGNLVP SLAKDWKVS KDGLTYTYTLRDGVSWYTADGEEYAPVTAEDFVTGLKHAVDDKSDALYV
 VEDSIKNL KAYQNGEVDFKEVGVKALDDKTVOYTLNKPESYWN SKTYSVLF PVNAKFLKSKGKDFGTTDP
 SSILVNGAYFLSAFTSKSSMEFHKNENYWD AKNVGIESVKLTYS DGS DPGSFYKNFDKGEFSVARLYPN DP
 TYKSAKKNYADNITYGMLTGD IRLHTWNLNRTSFKNTKKDPAQQDAGKKALNNKDFRQAIQFAFDRASFQA
 QTAGQDAKTKALRNMLVPPTFVTIGESDFGSEVEKEMAKLGDEWKDVNLADAQDGFYNPEKAKAEFAKAKE
 ALTAEGVTFPVQLDYPVDQANAATVQEAQSFKQSVEASLGKENVIVNVLETETSTHEAQGFYAETPEQQDY
 DI ISSWWGPDYQDPRTYLDIMSPVGGGSVIQKLG IKAGQNKDVVAAAGLDTYQTL LDEAAAITDDNDARYK
 AYAKAQAYLTDNAVDIPVVALGGTPRVTKAVPFSGGFSWAGSKGPLAYKGMKLQDKPVTVKQYEKAKEKWM
 KAKAKSNAKYAEKLADHVEK

SEQ ID NO: 97 polynucleotide sequence encoding GAS 45

GTGACTTTTATGAAGAAAAGTAAATGGTTGGCAGCTGTAAGTGTTGCGATCTTGTTCAGTATCCGCTTTGGC
 AGCTTGTGGTAATAAAAATGCTTCAGGTGGCTCAGAAGCTACAAAACCTACAAGTACGTTTTTGTTAACG
 ATCCAAAATCATTGGATTATATTTTACTAATGGCGGTGGAACGACTGATGTGATAACACAAATGGTTGAT
 GGTCTTTTGGAAAACGATGAGTATGGTAATTTAGTACCATCACTTGCTAAAGATTGGAAGGTTTCAAAGA
 CGGTCTGACTTATACTTATACTCTTCGCGATGGTGTCTCTTGGTATACGGCTGATGGTGAAGAATATGCC
 CAGTAACAGCAGAAGATTTTGTGACTGGTTTGAAGCACGCGGTGACGATAAATCAGATGCTCTTTACGTT
 GTTGAAGATTCAATAAAAAACTTAAAGGCTTACCAAATGGTGAAGTAGATTTTAAAGAAGTTGGTGTCAA
 AGCCCTTGACGATAAACTGTTTCAGTATACTTTGAACAAGCCTGAAAGCTACTGGAATTCAAAAACAACTT
 ATAGTGTGCTTTTCCAGTTAATGCGAAATTTTGAAGTCAAAGGTAAAGATTTTGGTACAACCGATCCA
 TCATCAATCCTTGTTAATGGTGCTTACTTCTTGAGCGCCTTCACCTCAAATCATCTATGGAATTCATAA
 AAATGAAAAC TACTGGGATGCTAAGAATGTTGGGATAGAATCTGTAAATTGACTTACTCAGATGGTTTCA
 ACCAGGTTCTGTTCTACAAGAACTTTGACAAGGGTGAGTTCAGCGTTGCACGACTTTACCCAAATGACCCT
 ACCTACAAATCAGCTAAGAAAACTATGCTGATAACATTACTTACGGAATGTTGACTGGAGATATCCGTCA
 TTTAACATGGAATTTGAACCGTACTTCTTTCAAAAACACTAAGAAAGACCCTGCACAACAAGATGCCGGTA
 AGAAAGCTCTTAACAACAAGGATTTTCGTCAAGCTATTCAGTTTGCTTTTGACCGAGCGTCATTCCAAGCA
 CAACTGCAGGTCAAGATGCCAAAACAAAAGCCTTACGTAACATGCTTGTTCCCAACCATTTGTGACCAT
 TGGAGAAAGTGATTTTGGTTTCAAGATTGAAAAGGAAATGGCAAACCTTGGTGATGAATGGAAAGACGTTA
 ACTTAGCTGATGCTCAAGATGGTTTCTATAATCCTGAAAAGCAAAGCTGAGTTTGCAAAGCCAAAGAA

SEQUENCE LISTING

GCTTTAACAGCTGAAGGTGTAACCTTCCCAGTTCAATTAGATTACCCTGTTGACCAAGCAAACGCAGCAAC
 TGTTTCAGGAAGCCCAGTCTTTCAAACAATCTGTTGAAGCATCTCTTGGTAAAGAGAATGTCATTGTCAATG
 TTCTTGAAACAGAAACATCAACTCACGAAGCCCAAGGCTTCTATGCTGAGACCCCAGAACAACAAGACTAC
 GATATCATTTTCATCATGGTGGGGACCAGACTATCAAGATCCACGGACCTACCTTGACATCATGAGTCCAGT
 AGGTGGTGGATCTGTTATCCAAAACTTGGAATCAAAGCAGGTCAAAAATAAGGATGTTGTGGCAGCTGCAG
 GCCTTGATACCTACCAAACCTCTTCTTGATGAAGCAGCAGCAATTACAGACGACAACGATGCGCGCTATAAA
 GCTTACGCAAAAGCACAAGCCTACCTTACAGATAATGCCGTAGATATTCCAGTTGTGGCATTGGGTGGCAC
 TCCACGAGTTACTAAAGCCGTTCCATTTAGCGGGGGCTTCTCTTGGGCAGGGTCTAAAGGTCCTCTAGCAT
 ATAAAGGAATGAACTTCAAGACAAACCTGTCACAGTAAACAATACGAAAAAGCAAAAGAAAAATGGATG
 AAAGCAAAGGCTAAGTCAAATGCAAATATGCTGAGAAGTTAGCTGATCACGTTGAAAAA

SEQ ID NO: 98 amino acid sequence comprising an N-terminal leader sequence of GAS 45
 VTFMKKSKWLAAVSVAILSVSALAA

SEQ ID NO: 99 amino acid sequence comprising a fragment of GAS 45 where the N-terminal
 leader sequence is removed

CGNKNASGGSEATKTYKYVFVNDPKSLDYILTNGGGTTDVITQMVDGLLÉNDEYGNLVP SLAKDWKVKSKDG
 LTYTYTLRDGVSWYTADGEEYAPVTAEDFVTGLKHAVDDKSDALYVVEDSIKNLKAYQNGEVDFKEVGVKA
 LDDKTQYTLNKPESYWN SKTTSVLFVNAKFLKSKGKDFGTTDPSSILVNGAYFLSAFTSKSSMEFHKN
 ENYWDANKVNGIESVKLTYSDGSDPGSFYKNFDKGEFSVARLYPNDPTYKSAKKNYADNITYGMLTGDIRHL
 TWNLNRTSFKNTKKDPAQQDAGKKALNNKDFRQAIQFAFDRASFQAQTAGQDAKTKALRNMLVPPTFVTIG
 ESDFGSEVEKEMAKLGDEWKDVNLADAQDGFYNPEKAKAEFAKAKEALTAEGVTFPVQLDYPVDQANAATV
 QEAQSFQKQSVEASLGKENVIVNVLETETSTHEAQGFYAETPEQQDYDI ISSWWGPDYQDPRTYLDIMSPVG
 GGSVIQKLGIKAGQNKDVVAAAGLDTYQTLLEAAAITDDNDARYKAYAKAQAYLTDNAVDIPVVALGGTP
 RVTKAVPFSGGFSWAGSKGPLAYKGMKLQDKPVTVKQYEKAKEKWMKAKAKSNAKYAEKLADHVEK

SEQ ID NO: 100 amino acid sequence comprising GAS 95

MKIGKKIVLMFTAIVLTTVLALGVYLTSAYTFSTGELSKTFKDFSTSSNKSDAIKQTRAFSILLMGVDTGS
 SERASKWEGNSDSMILVTVPKTKKTTMTSLERD LTTLSGPKNNEMNGVEAKLNAAYAAGGAQMAIMTVQ
 DLLNITIDNYVQINMQGLIDLVA VGGITVTNEFDFPISIAENEPEYQATVAPGTHKINGEQALVYARMRY
 DDPEGDYGRQKRQREVIQKVLKKILALDSISSYRKILSAVSSNMQTNIEISSRTIPSL LGYRDALRTIKTY
 QLKGEDATLSDGGSYQIVTSNHLLEIQNRIRTELGLHKVNQLKTNATVYENLYGSTKSQTVNNNYDSSGQA
 PSYSDSHSSYANYSSGVD TGQSASTDQDSTASSHRPATPSSSSDALAADESSSSSGSGLVPPANINPQT

SEQ ID NO: 101 polynucleotide sequence encoding GAS 95

ATGAAAATTGGAAAAAAATAGTTTTAATGTTACAGCTATTGTGTTAACAACCTGTCCTTGGCATTAGGTGT
 CTATCTAACTAGTGCTTATACCTTCTCAACAGGAGAATTATCAAAGACCTTTAAAGATTTTTCGACATCTT
 CAAACAAAAGTGATGCCATTAAACAACAAGAGCTTTTTCTATCTTGTGATGGGTGTTGATACAGGCTCT
 TCAGAGCGTGCCCTCCAAGTGGGAAGGAAACAGTGATTTCGATGATTTTGGTTACGGTTAATCCAAGACCAA
 GAAAACAACCTATGACTAGTTTAGAACGAGATACCTTAACCACGTTATCTGGACCCAAAAATAATGAAATGA
 ATGGTGTTGAAGCTAAGCTTAACGCTGCTTATGCAGCAGGTGGCGCTCAGATGGCTATTATGACCGTGCAA
 GATCTTTTGAATATCACCATTGATAACTATGTTCAAATTAATATGCAAGGCCTTATTGATCTTGTGAATGC
 AGTTGGAGGGATTACAGTTACAAATGAGTTTGATTTTCTATCTCGATTGCTGAAAACGAACCTGAATATC
 AAGCTACTGTTGCGCCTGGAACACACAAAATTAACGGTGAACAAGCTTTGGTTTATGCTCGTATGCGTTAT
 GATGATCCTGAGGGAGATTATGGTCGACAAAAGCGTCAACGTGAAGTCATTCAAAGGTATTGAAAAAAT
 CCTTGCTCTTGATAGCATTAGCTCTTATCGGAAGATTTTATCTGCTGTAAGTAGTAATATGCAAACGAATA
 TCGAAATCTCTTCTCGCACTATCCCTAGTCTATTAGGTATCGTGACGCACTTAGAACTATTAAGACTTAT
 CAACTAAAAGGAGAAGATGCCACTTTATCAGATGGTGGATCATAACCAATTGTTACCTCTAATCATTTGTT
 AGAAATCCAAAATCGTATCCGAACAGAATTAGGACTTCATAAGGTTAATCAATTAAAAACAAATGCTACTG
 TTTATGAAAATTTGTATGGGTCAACTAAGTCTCAGACAGTAAACAACAACCTATGACTCTTCAGGCCAGGCT
 CCATCTTATTCTGATAGTCATAGCTCTTACGCTAATTATTCAAGTGGAGTAGATACCGGCCAGAGTGCTAG
 TACAGACCAGGACTCTACTGCTTCAAGCCATAGGCCAGCTACGCCGTCTTCTTCATCAGATGCTTTAGCAG
 CTGATGAGTCTAGCTCATCAGGGTCTGGATCATTAGTTCTCTCTGCTAATATCAACCCTCAGACCTAA

SEQ ID NO: 102 amino acid sequence comprising N-terminal leader sequence of GAS 95
 MKIGKKIVLMFTAIVLTTVLALGVYLTSAYTFS

SEQUENCE LISTING

SEQ ID NO: 103 amino acid sequence comprising a fragment of GAS 95 where the N-terminal leader sequence is removed.

TGELSKTFKDFSTSSNKSDAIKQTRAFSILLMGVDTGSSERASKWEGNSDSMILVTVPKTKKTTMTSLER
DTLTTLSPKNNEMNGVEAKLNAAYAAGGAQMAIMTVQDLLNITIDNYVQINMQGLIDLNVAVGGITVTNE
FDFPISIAENEPEYQATVAPGTHKINGEQALVYARMRYDDPEGDYGRQKRQREVIQVLKKILALDSISSY
RKILSAVSSNMQTNIEISSRTIPSLGGRDALRTIKTYQLKGEDATLSDGGSYQIVTSNHLLEIQNRIRTE
LGLHKVNQLKTNATVYENLYGSTKSQTVNNNYDSSGQAPSYSDSHSSYANYSSGVDTGQSASTDQDSTASS
HRPATPSSSSDALAADESSSSSGSLVPPANINPQT

SEQ ID NO: 104 amino acid sequence comprising GAS 193

MKKRKLAVTLLSTILLNSAVPLVVADTSLRNSTSSDQPTTADTDTTDESETPKKDKKSKETASQHDTQK
DHKPSHTHTPTPPSNDTKQTDQASSEATDKPNKDKNDTKQPDSSDQSTPSPKQSSQKESQNKDGRPTPSPD
QQKDQTPDKTPEKSADKTPEKGPEKATDKTPEPNRDAPKPIQPPLAAAPVFI PWRESKDLSKLKPSRSS
AAYVRHWTGDSAYTHNLLSRRYGITAEQLDGLNSLGIHYDKERLNGKRLLEWEKLTGLDVRAIVAIAMAE
SSLGTQGVAKKEGANMFGYGAFFDNPNNAKKYSDEVAIRHVMEDTIIANKNQTFERQDLKAKKWSLGQLDT
LIDGGVYFTDTS GSGQRRADIMTKLDQWIDDHGSTPEIPEHLKITSQTQFSEVPVGYKRSQPQNVLTYSKSE
TYSFGQCTWYAYNRVKELGYQVDRYMGNGGDWQRKPGFVTTHKPKVGYVVSFAPGQAGADATYGHVAVVEQ
IKEDGSILISESNVMGLGTISYRTFTAEQASLLTYVVGDKLPRP

SEQ ID NO: 105 polynucleotide sequence encoding GAS 193

ATGAAGAAAAGGAAATTGTTAGCAGTAACACTATTAAGTACCATACTCTTAAACAGTGCAGTGCCATTAGT
TGTTGCTGATACCTCCTTGCGTAATAGCACATCATCCACTGATCAGCCTACTACAGCAGATACTGATACGG
ATGACGAGAGTGAAACACCAAAAAAGACAAAAAAGCAAGGAAACAGCGTCGCAGCACGACACCCAAAAA
GACCATAAGCCATCACACACTCACCCAACCCCCCTTCAAATGATACTAAGCAGACCGATCAGGCATCATC
TGAAGCTACTGACAAACCAATAAAGACAAAAACGACACCAAGCAACCAGACAGCAGTGATCAATCCACCC
CATCTCCCAAAGACCAGTCGTCTCAAAAAGAGTCACAAAACAAAGACGGCCGACCTACCCCATCACCTGAT
CAGCAAAAAGATCAGACACCTGATAAAACACCAGAAAAATCAGCTGATAAAACCCCTGAAAAAGGACCAGA
AAAAGCAACTGATAAAACACCAGAGCCAAATCGTGACGCTCCAAAACCCATCCAACCTCCTTTAGCAGCTG
CTCCTGTCTTTATACCTTGGAGAGAAAGTGACAAAGACCTGAGCAAGCTAAAACCAAGCAGTCGCTCATCA
GCGGCTTACGTGAGACACTGGACAGGTGACTCTGCCTACACTCACAACCTGTTGTCACGCCGTTATGGGAT
TACTGCTGAACAGCTAGATGGTTTTTTGAACAGTCTAGGTATTCATATGATAAAGAACGCTTAAACGGAA
AGCGTTTATTAGAATGGGAAAAACTAACAGGACTAGACGTTTCGAGCTATCGTAGCTATTGCAATGGCAGAA
AGCTCACTAGGTACTCAGGGAGTTGCTAAAGAAAAAGGAGCCAATATGTTTGGTTATGGCGCCTTTGACTT
CAACCCAAACAATGCCAAAAAATACAGCGATGAGGTTGCTATTCGTACATGGTAGAAGACACCATCATTG
CCAACAAAAACCAACCTTTGAAAGACAAGACCTCAAAGCAAAAAAATGGTCACTAGGCCAGTTGGATACC
TTGATTGATGGTGGGGTTTACTTTACAGATACAAGTGGCAGTGGGCAAGACGAGCAGATATCATGACCAA
ACTAGACCAATGGATAGATGATCATGGAAGCACACCTGAGATTCCAGAACATCTCAAGATAACTTCCGGGA
CACAATTTAGCGAAGTGCCCGTAGGTTATAAAGAAGTCAGCCACAAAACGTTTTGACCTACAAGTCAGAG
ACCTACAGCTTTGGCCAATGCACTTGGTACGCCTATAATCGTGTCAAAGAGCTAGGTTATCAAGTCGACAG
GTACATGGGTAACGGTGGCGACTGGCAGCGCAAGCCAGGTTTTGTGACCACCCATAAACCTAAAGTGGGCT
ATGTCGTCTCATTTGCACCAGGCCAAGCAGGAGCAGATGCAACCTATGGTCACGTTGCTGTTGTAGAGCAA
ATCAAAGAAGATGGTCTATCTTAATTTAGAGTCAAATGTTATGGGACTAGGCACCATTTCTATCGGAC
GTTACAGCTGAGCAGGCTAGTTTGTGACCTATGTCGTAGGGGACAAACTCCCAAGACCATAA

SEQ ID NO: 106 amino acid sequence comprising GAS 137

MSDKHINLVIVTGMSGAGKTVAIQSFEDLGYFTIDNMPPALVPKFLELIEQTNENRRVALVVDMRSLFFK
EINSTLDSIESNPSIDFRILFLDATDDELVSRYKETRRSHPLAADGRVLDGIRLERELLSPLKSMSQHVVD
TTKLTPRQLRKTISDQFSEGSNQASFRIEVMFSGFKYGLPLDADLVFDVRFNPYPYQVELREKTGLDEDV
FNYVMSPHPESEVFYKHLNLIVPILPAYQKEGKSVLTVAIGCTGGQHRVAFHCLAESLATDWSVNESH
DQNRKRVNRS

SEQ ID NO: 107 polynucleotide sequence encoding GAS 137

ATGTCAGACAAACACATTAATTTAGTTATTGTGACAGGAATGAGCGGCGCTGGAAAAACAGTTGCCATTCA
GTCTTTTGGAGATCTAGGCTACTTTACCATTGATAATATGCCCCAGCCTTGGTTCCAAAATTTTGTAGAAT
TAATTGAACAAACCAATGAAAATCGTAGGGTGGCTTTGGTTGTGATATGAGAAGTCGTTTGTGTTTCAAG

SEQUENCE LISTING

GAAATTAATTCTACCTTAGATAGTATTGAAAGCAATCCTAGCATTGATTTTCGGATTCTTTTTTTGGATGC
AACGGATGGAGAATTGGTGTACGCTATAAAGAAACCAGACGGAGCCACCCTTTGGCTGCGGACGGTCGTG
TGCTTGATGGTATTCGATTGGAAAGAGAACTCCTATCTCCTTTGAAAAGCATGAGCCAACATGTGGTGGAT
ACAACAAAATTGACCCCTAGACAATTGCGTAAAACCATTTTCAGACCAGTTTCTGAAGGGTCTAATCAAGC
CTCTTTCCGTATTGAAGTGATGAGCTTTGGGTTCAAATATGGTCTTCCTTTGGATGCGGATTTGGTTTTTG
ATGTGCGTTTTCTACCCAATCCTTATTATCAGGTAGAGCTTCGTGAAAAACAGGACTAGATGAGGACGTT
TTTAATTATGTGATGTCTCACCAGAATCAGAGGTGTTTTACAAGCATTTGTTAAACCTTATTGTCCCTAT
CTTACCGGCTTACCAAAAAGAAGGGAAGTCTGTCTTGACGGTGGCTATTGGCTGCACAGGAGGCCAACACC
GCAGCGTTGCCCTTTGCCCATTTGCTTGGCAGAAAGTCTGGCAACAGATTGGTTCGGTTAATGAAAGCCATCGT
GATCAAAATCGTCGTAAGGAAACGGTGAATCGTTCATGA

SEQ ID NO: 108 amino acid sequence comprising GAS 84

MIKKRTVAILAIASSFFLVACQATKSLKSGDAWGVYQKQKSITVGFDNTFVPMGYKDESGRCKGFDIDLA
KEVFHQYGLKVNQAINWDMKEAELNNGKIDVIWNGYSITKERQDKVAFTDSYMRNEQIIIVVKRSDIKTI
SDMKHKVLGAQSASSGYDSLRLTPKLLKDFIKNKDANQYETFTQAFIDLKSDRIDGILIDKVYANYYLAK
EQLENYRMIPTTFENEAFSVGLRKEDKTLQAKINRAFRVLYQNGKFQAISEKWFQDDVATANIKS

SEQ ID NO: 109 polynucleotide sequence encoding GAS 84

ATGATTATAAAAAAAGAACCGTAGCAATTTTAGCCATAGCTAGTAGCTTTTCTTGGTAGCTTGTCGAAGC
TACTAAAAGTCTTAAATCAGGAGATGCTTGGGGAGTTTACCAAAAGCAAAAAAGTATTACAGTTGGTTTTG
ACAATACGTTTGTTCCTATGGGCTATAAGGATGAAAGCGGCAGATGCAAAGGTTTGTATATTGATTTGGCT
AAAGAAGTTTTTTCACCAATATGGACTCAAGGTTAACTTTCAAGCTATTAATTGGGACATGAAAGAAGCAGA
ACTAAACAATGGTAAATGATGTAATCTGGAATGGTTATTCAATAACTAAGGAGCGTCAGGATAAGGTTG
CCTTTACTGATTCTTACATGAGAAATGAACAAATTATTGTTGTCAAAAAAAGATCTGATATTAAAACAATA
TCAGATATGAAACATAAAGTGTTAGGAGCACAAATCAGCTTCATCAGGTTATGACTCCTTGTTAAGAACTCC
TAAACTGCTGAAAGATTTTATTAAAAATAAAGACGCTAATCAATATGAAACCTTTACACAAGCTTTTATTG
ATTTAAAATCAGATCGTATCGATGGAATATTGATTGACAAAGTATATGCCAATTACTATTTAGCAAAAGAA
GGGCAATTAGAGAATTATCGGATGATCCCAACGACCTTTGAAAATGAAGCATTTTTCGGTTGGACTTAGAAA
AGAAGACAAAACGTTGCAAGCAAAAATTAATCGTGCTTTCAGGGTGCTTTATCAAAATGGCAAATTTCAAG
CTATTTCTGAGAAATGGTTTGGAGATGATGTTGCCACTGCCAATATTAAATCTTAA

SEQ ID NO: 110 amino acid sequence comprising N-terminal leader sequence of GAS 84

MIKKRTVAILAIASSFFLVA

SEQ ID NO: 111 amino acid sequence comprising a fragment of GAS 84 where the N-terminal leader sequence is removed

CQATKSLKSGDAWGVYQKQKSITVGFDNTFVPMGYKDESGRCKGFDIDLAKEVFHQYGLKVNQAINWDMK
EAELNNGKIDVIWNGYSITKERQDKVAFTDSYMRNEQIIIVVKRSDIKTISDMKHKVLGAQSASSGYDSL
RTPKLLKDFIKNKDANQYETFTQAFIDLKSDRIDGILIDKVYANYYLAKQLENYRMIPTTFENEAFSVG
LRKEDKTLQAKINRAFRVLYQNGKFQAISEKWFQDDVATANIKS

SEQ ID NO: 112 amino acid sequence comprising GAS 384

MKTLAFDTSNKTLSLAILDDETLADMTLNIQKKHSVSLMPAIDFLMTCTDLKPQDLERIVVAKGPGSYTG
LRVAVATAKTLAYSLNIALVGISSLYALAASTCKQYPNTLVVPLIDARRQNAYVGYRQKSVMPQAHASL
EVIIEQLVEEGQLIFVGETAPFAEKIQKKLPQAILLPTLPSAYECGLLGQSLAPENVDAFVPQYLKRVEAE
ENWLKDNEIKDDSHYVKRI

SEQ ID NO: 113 polynucleotide sequence encoding GAS 384

ATGAAGACACTTGCATTTGATACCTCAAATAAAACCTTGTCCTTGCTATACTTGATGATGAGACACTTCT
AGCAGATATGACCCTTAACATTCAGAAAAACATAGTGTTAGCCTTATGCCTGCTATTGATTTTTTGATGA
CTTGTAATGATCTTAAACCTCAAGATTTAGAAAGAATAGTGGTTGCAAAAGGCCCTGGATCTTACACAGGT
TTACGAGTGGCAGTTGCTACTGCAAAAACGTTAGCGTACAGTTTAAATATTGCATTGGTCGGGATTTTCGAG
TCTATATGCTTTGGCTGCGTCTACTTGTAACAGTATCCAAATACTTTGGTGGTGCCATTGATTGATGCTA
GAAGGCAAAATGCGTATGTAGGTTATTATCGGCAAGGAAAATCAGTGATGCCACAAGCCCATGCTTCACTA
GAAGTTATTATAGAACAATTAGTAGAAGAAGGACAGCTGATTTTTGTTGGGGAGACTGCTCCTTTTGCTGA

SEQUENCE LISTING

GAAAATTCAAAGAACTACCTCAGGCGATACTACTTCCAACCCTTCCTTCTGCTTACGAATGTGGTCTTT
TGGGGCAAAGTTTGGCACCAGAAAATGTAGACGCCTTTGTCCCTCAATATCTCAAGAGAGTGAAGCTGAA
GAAACTGGCTCAAAGATAATGAGATAAAAGATGATAGTCACTACGTAAAGCGAATCTAA

SEQ ID NO: 114 amino acid sequence comprising GAS 202

MLKRLWLILGPLLIAFVLVVITIFSFPTQLDHSIAQEKANAVAITDSSFKNGLIKRQALSDETCRFVPPFFG
SSEWSRMDSMHPSVLAERYKRSYRPFLLIGKRGASLSHYYGIIQQITNEMQKKKAIFFVSPQWFTAQGINPS
AVQMYLSNTQVIEFLLKARTDKESQFAAKRLLELNPGVSKSNLLKKVSKGKSLSRDLRAILKCQHQVALRE
ESLFSFLGKSTNYEKRIILPRVKGLPKVFSYKQLNALATKRGQLATTNNRFGIKNTFYRKRIAPKYNLYKNF
QVNSYLASPEYNDFQLLLSEFAKRKTDVLFVITPVNKAWADYTGLENQDKYQAAVRKIKFQLKSQGFHRIA
DFSKDGGESYFMQDTIHLGWNGWLAFFDKKVQPFLETKQVPVNYKMNPFYFSKIWANRKDLQ

SEQ ID NO: 115 polynucleotide sequence encoding GAS 202

ATGCTTAAGAGACTCTGGTTAATTCTAGGTCCTCTTCTTATTGCCTTTGTTTTAGTAGTGATTACTATTTT
TAGTTTTCTACACAACCTTGATCATTCCATAGCTCAGGAAAAAGCAAATGCCGTTGCGATCACAGATAGTT
CTTTTAAAAATGGTTTGATTAAAAGACAAGCTTTATCAGATGAGACTTGTCGTTTTGTGCCTTTTTTTGGT
TCTAGCGAATGGAGTCGAATGGATAGTATGCACCCCTTCGGTGCTTGCAAGAGCGCTACAAGCGGAGCTATAG
ACCATTTTTTAATTGGTAAGAGAGGATCAGCATCTTTGTGCGCATTATTATGGTATACAACAATTACCAATG
AAATGCAAAAGAAAAAGCCATCTTTGTAGTATCTCCTCAATGGTTTACTGCTCAAGGGATTAATCCTAGT
GCGGTTTCAGATGTACTTGTCTAACACTCAAGTGATTGAATTTTTACTAAAAGCTAGAACTGATAAAGAATC
ACAGTTTGCAGCAAAGCGTTTGCTTGAGCTTAACCCTGGTGTGTCTAAATCAAACCTTATTGAAAAAGTAA
GTAAGGGTAAGTCTCTTAGTCGGTTAGACAGAGCTATTTTGAAATGTCAACATCAAGTAGCATTGAGAGAA
GAGTCCCTTTTTTAGTTTTTTAGGCAAATCTACTAATATGAAAAAGAATTTTGCCTCGCGTTAAGGGATT
ACCTAAAGTATTTTCGTATAACAATTGAATGCATTAGCAACTAAGAGAGGCCAATTAGCAACAACCAACA
ACCGTTTTTGGGATTAAAAATACATTTTATCGTAAACGAATAGCACCTAAATACAATCTTTATAAGAATTC
CAAGTTAATTATAGTTACCTGGCGTCACCAGAATACAATGATTTTCAGCTTTTATTATCAGAATTTGCTAA
ACGAAAAACAGATGTACTCTTTGTTATACTCCTGTATAAAGCTTGGGCGGATTATACCGGCTTAAATC
AAGATAAGTATCAAGCGGCAGTTCGTAAAATAAAATTCAGTTAAAGTCACAAGGATTTTCATCGCATTGCT
GACTTCTCAAAGATGGTGGTGAGTCCTACTTTATGCAAGATACCATCCATCTCGGTTGGAATGGCTGGTT
AGCTTTTGATAAGAAAGTGCAACCATTTCTAGAAACGAAGCAGCCAGTGCCCAACTATAAAATGAACCCTT
ATTTTATAGTAAAATTTGGGCAAATAGGAAAGACTTGCAATAG

SEQ ID NO: 116 amino acid sequence comprising GAS 057

MEKKQRFSLRKYSKGFVSLIGSVFLVMTTVADELSTMSEPTITNHAQQQAQHLTNTELSSAESKSQDT
SQITLKTNREKEQSQDLVSEPTTTELADTDAASMAN TGSDATQKSASLPVNTDVHDWVKTKGAWDKGYKG
QGKVVAVIDTGDIDPAHQSMRISDVSTAKVSKEDMLARQKAAGINYGSWINDKVVFHNYVENSNDNIKENQ
FEDFDEDWENFEFDAEAEPKAIKKHKIYRPQSTQAPKETVIKTEETDGSHDIDWTQTDDDTKYESHGMHVT
GIVAGNSKEAAATGERFLGIAPEAQVMFMRVFANDIMGSAESLFIKAIEDAVALGADVNLISLGTANGAQL
SGSKPLMEAIEKAKKAGVSVVVAAGNERVYGSDDHDDPLATNP DYGLVGSPTGRTPTSVAAINS KWKVIQRL
MTVKELENRADLNHGKAIYSESVD FDKIDSLGYDKSHQFAYVKESTDAGYNAQDVKGKIALIERDPNKTY
DEMIALAKKHGALGVLI FNNKPGQSNRSMRLTANGMGIPSAFISHEFGKAMSQ L N G N T G S L E F D S V V S K A
PSQKGNEMNHFSNWGLTSDGYLKPDI TAPGGDIYSTYNDNHYGSQTGTSMAS PQIAGASLLVKQYLEKTQP
NLPKEKIADIVKNLLMSNAQIHVN PETKTTTSPRQQGAGLLNIDGAVTSGLYVTGKDNYSISLGNITDTM
TFDVTVHNLSNKDKTLRYDTELLTDHVD P Q K G R F T L T S H S L K T Y Q G G E V T V P A N G K V T V R V T M D V S Q F T K E
LTKQMPNGYYLEGFVRFRDSQDDQLNRVNI PFVGFKGQFENLAVAEESIYRLKSQGKTGFYFDES GPKDDI
YVGKHFTGLVTLGSETNVSTKTI SDNGLHTLGT FKNADGKFILEKNAQGNPVLAI SPNGDNNQDFAAFKGV
FLRKYQGLKASVYHASDKEHKNPLWVSPESFKGDKNFNSDIRFAKSTLLGTAFSGKSLTGAELPDGHYHY
VVSYYPDVVGAKRQEMTFDMILDRQKPVLSQATFDPETNRFKPEPLKDRGLAGVRKDSVFYLERKDNKPYT
VTINDSYKYVSVEDNKTFVERQADGSFILPLDKAKLGDFYYMVEDFAGNVAIAKLGDHLPQTLGKTPIK L K
LTDGNYQTKETLKNLEMTQSDTGLVTNQAQLAVVHRNQ PQS Q L T K M N Q D F F I S P N E D G N K D F V A F K G L K N
NVYNDLTVNVYAKDDHQKQTP IWSSQAGASVSAIESTAWYGITARGSKVMPGDYQYVV TYRDEHGKEHQKQ
YTISVNDKKPMITQGRFD TINGVDHFTPDKTKALDSSGIVREEVFYLA KKNRKFVDVTEGKDGITVSDNKV
YIPKNPDGSYTI SKRDGVTLSDYYYLVEDRAGNVSFATLRDLKAVGKDKAVVNFGLDLPVPEDKQIVNFTY
LVRDADGKPIENLEYNNNSGNSLILPYGKYTVELLYDTNAAKLES DKIVSFTLSADNNFQQVTFKITMLA
TSQITAHFDHLLPEGSRVSLKTAQDQLI PLEQSLYVPKAYGKTVQEGTYEVVVS L P K G Y R I E G N T K V N T L P

SEQUENCE LISTING

NEVHELRLRLVKVGDA SDSTGDHKVMSKNNSQALTASATPTKSTTSATAKALPSTGEKMGLKLRIVGLVLL
GLTCVFSRKKSTKD

SEQ ID NO: 117 polynucleotide sequence encoding GAS 057

GTGGAGAAAAAGCAACGTTTTTCCCTTAGAAAAATACAAATCAGGAACGTTTTTCGGTCTTAATAGGAAGCGT
TTTCTTGGTGATGACAACAACAGTAGCAGCAGATGAGCTAAGCACAATGAGCGAACCAACAATCACGAATC
ACGCTCAACAACAAGCGCAACATCTCACCAATACAGAGTTGAGCTCAGCTGAATCAAATCTCAAGACACA
TCACAAATCACTCTCAAGACAAATCGTGAAAAAGAGCAATCACAAGATCTAGTCTCTGAGCCAACCACAAC
TGAGCTAGCTGACACAGATGCAGCATCAATGGCTAATACAGGTTCTGATGCGACTCAAAAAAGCGCTTCTT
TACCGCCAGTCAATACAGATGTTTACGATTGGGTAAAAACCAAAGGAGCTTGGGACAAGGGATACAAAGGA
CAAGGCAAGGTTGTGCGCAGTTATTGACACAGGGATCGATCCGGCCCATCAAAGCATGCGCATCAGTGATGT
ATCAACTGCTAAAGTAAAATCAAAGAAGACATGCTAGCACGCCAAAAAGCCGCCGTATTAATTATGGGA
GTTGGATAAATGATAAAGTTGTTTTTGCACATAATTATGTGAAAAATAGCGATAATATCAAAGAAAATCAA
TTCGAGGATTTTGATGAGGACTGGGAAAACTTTGAGTTTGATGCAGAGGCAGAGCCAAAAGCCATCAAAAA
ACACAAGATCTATCGTCCCCAATCAACCCAGGCACCGAAAGAACTGTTATCAAAACAGAAGAAACAGATG
GTTACATGATATTGACTGGACACAAACAGACGATGACACCAATACGAGTCACACGGTATGCATGTGACA
GGTATTGTAGCCGGTAATAGCAAAGAAGCCGCTGCTACTGGAGAACGCTTTTTTAGGAATTGCACCAGAGGC
CCAAGTCATGTTTATGCGTGTTTTTGGCAACGACATCATGGGATCAGCTGAATCACTCTTTATCAAAGCTA
TCGAAGATGCCGTGGCTTTAGGAGCAGATGTGATCAACCTGAGTCTTGGAACCGCTAATGGGGCACAGCTT
AGTGGCAGCAAGCCTCTAATGGAAGCAATTGAAAAAGCTAAAAAAGCCGGTGTATCAGTTGTTGTAGCAGC
AGGAAATGAGCGCGTCTATGGATCTGACCATGATGATCCATTGGCGACAAATCCAGACTATGGTTTGGTCG
GTTCTCCCTCAACAGGTGCAACACCAACATCAGTGGCAGCTATAAACAGTAAGTGGGTGATTCAACGTCTA
ATGACGGTCAAAGAATTAGAAAACCGTGCCGATTTAAACCATGGTAAAGCCATCTATTCAAGAGTCTGTGCA
CTTTAAAGACATAAAAGATAGCCTAGGTTATGATAAATCGCATCAATTTGCTTATGTCAAAGAGTCAACTG
ATGCGGGTTATAACGCACAAGACGTTAAAGGTAAAATTGCTTTAATTGAACGTGATCCCAATAAAACCTAT
GACGAAATGATTGCTTTGGCTAAGAAACATGGAGCTCTGGGAGTACTTATTTTTAATAACAAGCCTGGTCA
ATCAAACCGCTCAATGCGTCTAACAGCTAATGGGATGGGGATACCATCTGCTTTCATATCGCACGAATTTG
GTAAGGCCATGTCCCAATTAAATGGCAATGGTACAGGAAGTTTAGAGTTTGACAGTGTGGTCTCAAAGCA
CCGAGTCAAAAAGGCAATGAAATGAATCATTTTTTCAAATTGGGGCCTAACTTCTGATGGCTATTTAAACC
TGACATTACTGCACCAGGTGGCGATATCTATTCTACCTATAACGATAACCACTATGGTAGCCAAACAGGAA
CAAGTATGGCCTCTCCTCAGATTGCTGGCGCCAGCCTTTTGGTCAAACAATACCTAGAAAAGACTCAGCCA
AACTTGCCAAAAGAAAAAATTGCTGATATCGTTAAGAACCTATTGATGAGCAATGCTCAAATTCATGTTAA
TCCAGAGACAAAACGACCACCTCACCGCGTCAGCAAGGGGCAGGATTACTTAATATTGACGGAGCTGTCA
CTAGCGGCCTTTATGTGACAGGAAAAGACAACCTATGGCAGTATATCATTAGGCAACATCACAGATACGATG
ACGTTTGATGTGACTGTTTACAACCTAAGCAATAAAGACAAAACATTACGTTATGACACAGAATTGCTAAC
AGATCATGTAGACCCACAAAAGGGCCGCTTCACTTTGACTTCTCACTCCTTAAAAACGTACCAAGGAGGAG
AAGTTACAGTCCCAGCCAATGGAAAAGTGACTGTAAGGGTTACCATGGATGTCTCACAGTTCACAAAAGAG
CTAACAAAACAGATGCCAAATGGTTACTATCTAGAAGGTTTGTCCGCTTTAGAGATAGTCAAGATGACCA
ACTAAATAGAGTAAACATTCCTTTTGTGGTTTTTAAAGGGCAATTTGAAAACCTTAGCAGTTGCAGAAGAGT
CCATTTACAGATTAAATCTCAAGGCAAACTGGTTTTTACTTTGATGAATCAGGTCCAAAAGACGATATC
TATGTCGGTAAACACTTTACAGGACTTGTCACTCTTGGTTCAGAGACCAATGTGTCAACCAAAACGATTTT
TGACAATGGTCTACACACACTTGGCACCTTTAAAAATGCAGATGGCAAATTTATCTTAGAAAAAATGCC
AAGGAAACCCTGTCTTAGCCATTTCTCCAAATGGTGACAACAACCAAGATTTTGCAGCCTTCAAAGGTGTT
TTCTTGAGAAAATATCAAGGCTTAAAAGCAAGTGCTACCATGCTAGTGACAAGGAACACAAAATCCACT
GTGGGTCAGCCAGAAAGCTTTAAAGGAGATAAAAACCTTTAATAGTGACATTAGATTTGCAAAATCAACGA
CCCTGTTAGGCACAGCATTTTCTGGAAAATCGTTAACAGGAGCTGAATTACCAGATGGGCATTATCATTAT
GTGGTGTCTTATTACCCAGATGTGGTTCGGTGCCAAACGTCAAGAAATGACATTTGACATGATTTTAGACCG
ACAAAACCGGTACTATCACAAGCAACATTTGATCCTGAAACAAACCGATTCAAACCAGAACCCTTAAAG
ACCGTGGATTAGCTGGTGTTCGCAAAGACAGTGTCTTTTATCTAGAAAGAAAAGACAACAAGCCTTATACA
GTTACGATAAACGATAGCTACAAATATGTCTCAGTAGAAGACAATAAAACATTTGTGGAGCGACAAGCTGA
TGGCAGCTTTATCTTGCCGCTTGATAAAGCAAAATTAGGGGATTTCTATTACATGGTTCGAGGATTTTGCAG
GGAACGTGGCCATCGCTAAGTTAGGAGATCACTTACCACAAACATTAGGTAAAACACCAATTAACTTAAG
CTTACAGACGGTAATTATCAGACCAAAGAAACGCTTAAAGATAATCTTGAAATGACACAGTCTGACACAGG
TCTAGTCACAAATCAAGCCCAGCTAGCAGTGGTGCACCGCAATCAGCCGCAAAGCCAGCTAACAAAGATGA
ATCAGGATTTCTTTATCTCACCAAACGAAGATGGGAATAAAGACTTTGTGGCCTTTAAAGGCTTGAAAAAT
AACGTGTATAATGACTTAACGGTTAACGTATACGCTAAAGATGACCACCAAAAACAAACCCCTATCTGGTC

SEQUENCE LISTING

TAGTCAAGCAGGCGCTAGTGTATCCGCTATTGAAAGTACAGCCTGGTATGGCATAACAGCCCGAGGAAGCA
 AGGTGATGCCAGGTGATTATCAGTATGTTGTGACCTATCGTGACGAACATGGTAAAGAACATCAAAAGCAG
 TACACCATATCTGTGAATGACAAAAAACCAATGATCACTCAGGGACGTTTTGATACCATTAATGGCGTTGA
 CCACTTTACTCCTGACAAGACAAAAGCCCTTGACTCATCAGGCATTGTCCGCGAAGAAGTCTTTTACTTGG
 CCAAGAAAAATGGCCGTAAATTTGATGTGACAGAAGGTAAAGATGGTATCACAGTTAGTGACAATAAGGTG
 TATATCCCTAAAAATCCAGATGGTTCTTACACCATTTCAAAAAGAGATGGTGTACACTGTCA GATTATTA
 CTACCTTGTCGAAGATAGAGCTGGTAATGTGTCTTTTGCTACCTTGCGTGACCTAAAAGCGGTCCGAAAAG
 ACAAAGCAGTAGTCAATTTTGGATTAGACTTACCGGTCCCTGAAGACAAACAAATAGTGAAC TTACCTAC
 CTTGTGCGGGATGCAGATGGTAAACCGATTGAAAACCTAGAGTATTATAATAACTCAGGTAACAGTCTTAT
 CTTGCCATACGGCAAATACACGGTCGAATTGTTGACCTATGACACCAATGCAGCCAAACTAGAGTCA GATA
 AAATCGTTTCCTTTACCTTGTCAGCTGATAACAAC TTCCAACAAGTTACCTTTAAGATAACGA TGTTAGCA
 ACTTCTCAAATAACTGCCCCACTTTGATCATCTTTTGCCAGAAGGCAGTCGCGTTAGCCTTAAA ACAGCTCA
 AGATCAGCTAATCCCGCTTGAACAGTCCTTGATGTGCC TAAAGCTTATGGCAAACCGTTCAAGAAGGCA
 CTTACGAAGTTGTTGTGTCAGCCTGCCTAAAGGCTACCGTATCGAAGGCAACACAAAGGTGAATACCCTACCA
 AATGAAGTGCACGAAC TATCATTACGCCTTGTCAAAGTAGGAGATGCCTCAGATTCAACTGGTGATCATAA
 GGTTATGTCAAAAAATAATTCACAGGCTTTGACAGCCTCTGCCACACCAACCAAGTCAACGACCTCAGCAA
 CAGCAAAAGCCCTACCATCAACGGGTGAAAAAATGGGTCTCAAGTTGCGCATAGTAGGTCTTGTTACTC
 GGACTTACTTGCGTCTTTAGCCGAAAAAAATCAACCAAAGATTGA

SEQ ID NO: 118 amino acid sequence comprising N-terminal leader sequence of GAS 57
 MEKKQRFSLRKYKSGTFSVLIGSVFLVMTTVA

SEQ ID NO: 119 amino acid sequence comprising a fragment of GAS 57 where the N-terminal leader sequence is removed

ADELSTMSEPTITNHAQQQAQHLTNTELSSAESKSQDTSQITLKTNREKEQSQDLVSEPTTTELADTDAAS
 MANTGSDATQKSASLPPVNTDVHDWVKTKGAWDKGYKGQGVVAVIDTGIDPAHQSMRISDVSTAKVKSKE
 DMLARQKAAGINYGSWINDKVVFAHNYVENS DN IKENQFEDFDEDWENFEFDAEAEPKAIKKHKIYRPOST
 QAPKETVIKTEETDGS HDIDWTQTD DDTKYESHGMHVTGIVAGNSKEAAATGERFLGIAPEAQVMFMRVFA
 NDIMGSAESLFIKAIEDAVALGADV INLSLGTANGAQLSGSKPLMEAIEKAKKAGVSVVVAAGNERVYGS D
 HDDPLATNP DYGLV GSPSTGRTP TSVAAINSKWVIQRLMTVKEL ENRADLNHGKAIYSESVD FKDIKDSL G
 YDKSHQFAYVKESTDAGYNAQDVKGKIALIERDPNKTYDEMIALAKKHGALGVLI FNNKPGQSNRSMRLTA
 NGMGIPSAFISHEFGKAMSQ L N GNGTGSLEFDSVVS KAPSQKGNEMNHFSNWGLTSDGYLKPDITAPGGDI
 YSTYNDNHYGSQTGTSMAS PQIAGASLLVKQYLEKTQPNLPKEKIADIVKNLLMSNAQIHVNPETKTTTSP
 RQQGAGLLNIDGAVTSGLYVTGKDNYGSI SLGNITDTMTFDVTVHNLSNKDKTLRYDTELLTDHVDPQKGR
 FTLTSHSLKTYQGGEVTV PANGKVTVRV TMDVSQFTKELTKQMPNGYYLEGFVRFRDSQDDQLNRVNI PFV
 GFKGQFENLAVAEESIYRLKSQKGTGFYFDESGPKDDIYVGKHFTGLVTLGSETNVSTKTI SDNGLHTLGT
 FKNADGKFILEKNAQGNPVLAI SPNGDNNQDFAAFKGVFLRKYQGLKASVYHASDKEHKNPLWVSPESFKG
 DKNFNSDIRFAKSTTLLGTAFSGKSLTGAELPDGHYHYVVSYPDVVGAKRQEMTFDMILDRQKPVLSQAT
 FDPETNRFKPEPLKDRGLAGVRKDSVFYLERKDNKPYTVTINDSYKYVSVEDNKT FVERQADGSFILPLDK
 AKLGDFFYMVEDFAGNVAIAKLGDHLPQTLGKTPIK LKLT DGN YQTKETLKNLEMTQSDTGLVTNQAQLA
 VVHRNQPSQLTKMNQDFFI SPNEDGNKDFVAFKGLKNNVYNDLTVNVYAKDDHQKQTP IWSSQAGASVSA
 IESTAWYGITARGSKVM PGDYQYVV TYRDEHGKEHQKYTISVNDKKPMITQGRFDTINGVDHFTPDKTKA
 LDSSGIVREEVFYLA KNGRKF DVTEGKDGITVSDNKVYI PKNPDGSYTI SKRDGVTLSDYYYLVEDRAGN
 VSFATLRDLKAVGKDKAVVNFGLDLPVPEDKQIVNFTYLVRDADGKPIENLEYNNSGNSLILPYGKYTVE
 LLTYDTNAAKLES DKIVSFTLSADNNFQQVTFKITMLATSQITAHFDHLLPEGSRVSLKTAQDQLI PLEQS
 LYVPKAYGKTVQEGTYEVVVS L PKGYRIEGNTKVNTLPNEVHEL SLRLVKVG DASDSTGDHKVMSKNNSQA
 LTASATPTKSTTSATAKALPSTGEKMGLKL RIVGLVLLGLTCVFSRKKSTKD

SEQ ID NO: 120 amino acid sequence comprising C-terminal hydrophobic region
 LPSTGEKMGLKL RIVGLVLLGLTCVFSRKKSTKD

SEQ ID NO: 121 amino acid sequence comprising a fragment of GAS 57 where the C-terminal hydrophobic region is removed

MEKKQRFSLRKYKSGTFSVLIGSVFLVMTTVA ADELSTMSEPTITNHAQQQAQHLTNTELSSAESKSQDT
 SQITLKTNREKEQSQDLVSEPTTTELADTDAAS MANTGSDATQKSASLPPVNTDVHDWVKTKGAWDKGYKG
 QGKVVAVIDTGIDPAHQSMRISDVSTAKVKSKE DMLARQKAAGINYGSWINDKVVFAHNYVENS DN IKENQ

SEQUENCE LISTING

FEDFDEDWENFEFDAEAEPKAIKKHKIYRPQSTQAPKETVIKTEETDGSHDIDWTQTD DDTKYESHGMHVT
 GIVAGNSKEAAATGERFLGIAPEAQVMFMRVFA NDIMGSAESLFIKAIEDAVALGADV INLSLGTANGAQL
 SGSKPLMEAIEKAKKAGVSVVVAAGNERVYGS DHDDPLATNP DYGLVGSPSTGRTP TSVAAINS KWVIQRL
 MTVKELENRADLNHGKAIYSESVDFKDIKDSLGYDKSHQFAYVKESTDAGYNAQDVKGKIALIERDPNKTY
 DEMIALAKKHGALGVLIFNNKPGQSNRSMRLTANGMGIPSAFISHEFGKAMSQNLNGNGTGSLEFDSVVSKA
 PSQKGNEMNHF SNWGLTSDGYLKPDI TAPGGDIYSTYNDNHYGSQTGTSMAS PQIAGASLLVKQYLEKTQP
 NLPKEKIADIVKNLLMSNAQIHVNPETKTTTSPRQQGAGLLNIDGAVTSGLYVTGKDN YGSI SLGNITDTM
 TFDVTVHNLSNKDKTLRYDTELLTDHVDPQKGRFTLTSHSLKTYQGGEVTV PANGKVTVRVTMDVSQFTKE
 LTKQMPNGYYLEGFVRFRDSQDDQLNRVNI PFVGFKGQFENLAVAEESIYRLKSQGKTGFYFDESGPKDDI
 YVGKHFTGLVTLGSETNVSTKTI SDNGLHTLGT FKNADGKFILEKNAQGNPVL AISPNGDNNQDFAAFKGV
 FLRKYQGLKASVYHASDKEHKNPLWVSPESFKGDKNFNSDIRFAKSTTLLGTAFSGKSLTGAELPDGHYHY
 VVSYPDVVGAKRQEMTFDMILDRQKPVLSQATFDPETNRFKPEPLKDRGLAGVRKDSVFYLERKDNKPYT
 VTINDSYKYVSVEDNKTFVERQADGSFILPLDKAKLGDFYVMVEDFAGNVAIAKLGDHLPQTLGKTPIKLLK
 LTDGNYQTKETLKDNL EMTQSDTGLVTNQAQLAVVHRNQ PQSQLTKMNQDFFISPNE DGNKDFVAFKGLKN
 NVYNDLTVNVYAKDDHQKQTP IWSSQAGASVSAIESTAWYGITARGSKVMPGDYQYVV TYRDEHGKEHQKQ
 YTISVNDKKPMITQGRFDTINGVDHFTPDKTKALDSSGIVREEVFYLAKKNGRKFDVTEGKDGITVSDNKV
 YIPKNPDGSYTI SKRDGVTLS DYYYLVEDRAGNVSFATLRDLKAVGKDKAVVNFGLDLPVPEDKQIVNFTY
 LVRDADGKPIENLEYNNSGNSLILPYGKYTVELLTYDTNAAKLESDKIVSFTLSADNNFQQVTFKITMLA
 TSQITAHFDHLLPEGSRVSLKTAQDQLIPLEQSLYVPKAYGKTVQEGTYEVVVS LPKG YRIEGNTKVNTLP
 NEVHEL SLRLVKVG DASDSTGDHKVMSKNNSQAL TASATPTKSTTSATAKA

SEQ ID NO: 122 amino acid sequence comprising a fragment of GAS 57 where both the N-terminal leader sequence and the C-terminal hydrophobic region are removed

ADELSTMSEPTITNHAQQQAQHLTNTELSSAESKSQDTSQITLKTNREKEQSQDLVSEPTTTELADTDAAS
 MANTGSDATQKSASLPPVNTDVHDWVKTKGAWDKGYKGQGVVAVIDTGIDPAHQSMRI SDVSTAKVKSKE
 DMLARQKAAGINYG SWINDKVVF AHNYVENS DN IKENQFEDFDEDWENFEFDAEAEPKAIKKHKIYRPQST
 QAPKETVIKTEETDGS HDIDWTQTD DDTKYESHGMHVTGIVAGNSKEAAATGERFLGIAPEAQVMFMRVFA
 NDIMGSAESLFIKAIEDAVALGADV INLSLGTANGAQLSGSKPLMEAIEKAKKAGVSVVVAAGNERVYGS D
 HDDPLATNP DYGLVGSPSTGRTP TSVAAINS KWVIQRLMTVKEL ENRADLNHGKAIYSESVDFKDIKDSL G
 YDKSHQFAYVKESTDAGYNAQDVKGKIALIERDPNKTYDEMIALAKKHGALGVLIFNNKPGQSNRSMRLTA
 NGMGIPSAFISHEFGKAMSQNLNGNGTGSLEFDSVVSKAPSQKGNEMNHF SNWGLTSDGYLKPDI TAPGGDI
 YSTYNDNHYGSQTGTSMAS PQIAGASLLVKQYLEKTQPNLPKEKIADIVKNLLMSNAQIHVNPETKTTTSP
 RQQGAGLLNIDGAVTSGLYVTGKDN YGSI SLGNITDTMTFDVTVHNLSNKDKTLRYDTELLTDHVDPQKGR
 FTLTSHSLKTYQGGEVTV PANGKVTVRVTMDVSQFTKELTKQMPNGYYLEGFVRFRDSQDDQLNRVNI PFV
 GFKGQFENLAVAEESIYRLKSQGKTGFYFDESGPKDDIYVGKHFTGLVTLGSETNVSTKTI SDNGLHTLGT
 FKNADGKFILEKNAQGNPVL AISPNGDNNQDFAAFKGVFLRKYQGLKASVYHASDKEHKNPLWVSPESFKG
 DKNFNSDIRFAKSTTLLGTAFSGKSLTGAELPDGHYHYVVSYPDVVGAKRQEMTFDMI LDRQKPVLSQAT
 FDPETNRFKPEPLKDRGLAGVRKDSVFYLERKDNKPYT VTINDSYKYVSVEDNKTFVERQADGSFILPLDK
 AKLGDFYVMVEDFAGNVAIAKLGDHLPQTLGKTPIKLLK LTDGNYQTKETLKDNL EMTQSDTGLVTNQAQLA
 VVHRNQ PQSQLTKMNQDFFISPNE DGNKDFVAFKGLKN NVYNDLTVNVYAKDDHQKQTP IWSSQAGASVSA
 IESTAWYGITARGSKVMPGDYQYVV TYRDEHGKEHQKQYTI SVNDKKPMITQGRFDTINGVDHFTPDKTKA
 LDSSGIVREEVFYLAKKNGRKFDVTEGKDGITVSDNKVYIPKNPDGSYTI SKRDGVTLS DYYYLVEDRAGN
 VSFATLRDLKAVGKDKAVVNFGLDLPVPEDKQIVNFTYLVRDADGKPIENLEYNNSGNSLILPYGKYTVE
 LLTYDTNAAKLESDKIVSFTLSADNNFQQVTFKITMLATSQITAHFDHLLPEGSRVSLKTAQDQLIPLEQS
 LYVPKAYGKTVQEGTYEVVVS LPKG YRIEGNTKVNTLPNEVHEL SLRLVKVG DASDSTGDHKVMSKNNSQA
 LTASATPTKSTTSATAKA

SEQ ID NO: 123 amino acid sequence of a GAS M protein

MAKNNTNRHYSRLKLTGTASVAVALTVLGAGFANQTEVKANGDGNPREVIEDLAANNPAIQNIRLRYENK
 DLKARLENAMEVAGRDFKRAEELEKAKQALE DQRKDLETKLKLQDDYDLAKESTSWDRQRLEKELEEKKE
 ALELAIDQASRDYHRATALEKELEEKKKALELAIDQASQDYNRANVLEKELETITREQETINRNLLGNAKLE
 LDQLSSEKEQLTIEKAKLEEEKQISDASRQSLRRDLASREAKKQVEKDLANLTAELDKVKEDKQISDASR
 QGLRRDLASREAKKQVEKDLANLTAELDKVKEEKQISDASRQGLRRDLASREAKKQVEKALEEANSKLA
 ALEKLNKELEESKKLTEKEKAELQAKLEAEAKALKEQLAKQAEELAKLRAGKASDSQTPDTKPGNKAVPGK
 GQAPQAGTKPNQNKAPMKETKRQLPSTGETANPFFTAALTVMATAGVA AVVKRKEEN

SEQUENCE LISTING

SEQ ID NO: 124 amino acid sequence of GAS SfbI

MSFDGFFLHHLTNELKENLLYGRIQKVNQPFERELVLTIRNHRKNYKLLLSAHPVFGRVQITQADFQNPQV
 PNTFTMIMRKYLGAVIEQLEQIDNDRIEIKVSNKNEIGDAIQATLI IEIMGKHSNI ILVDRAENKIIES
 IKHVGFSONSYRTILPGSTYIEPPKTA AVNPFTITDVPLFEILQTQELTVKSLQQHFQGLGRDTAKELAE
 LTDDKLKRFREFFARPTQANLTTASFAPVLFSDSHATFETLSMDLDFYQDKAERDRINQQASDLIHRVQT
 ELDKNRNKLKSKQEAELLATENAELFRQKGELLTTYLSLVPNNQDSVILDNYTGEKIEIALDKALTPNQNA
 QRYFKKYQKLKEAVKHL SGLIADTKQSITYFESVDYNLSQASIDDIEDIREELYQAGFLKSRQDRKHKRK
 KPEQYLASDGTITILMVGRNNLQNEELTFKMAKKGELWFHAKDIPGSHV I IKDNLDP SDEVKTDAAELAAYY
 SKARLSNLVQVDMIEAKKLHKPSGAKPGFVITYTGQKTLRVTPDQAKILSMKLS

SEQ ID NO: 125 amino acid sequence of a GAS Shp protein

MTKVVIKQLLQVIVVFMISLSTMTNLVYADKGQIYGCIIQRNYRHPISGQIEDSGGEHSFDIGQGMVEGTV
 YSDAMLEVSDAGKIVLTFRMSLADYSGNYQFWIQPGGTGSFQAVDYNITQKGTDTNGTTLDAISLPTVNS
 IIRGSMFVEPMGREVVFYLSASELIQKYSNMMLAQLVTETDNSQNQEVKDSQKPVDTKLGESQDESHTGAM
 ITQNKPKANSNNKSLSDKKILPSKMGLTTSLELKKEDKFRSKKDL SIMIYYFPTFFLMLGGFAVWVWKKR
 KKNDKTM

SEQ ID NO: 126 amino acids 10 to 30 of GAS protein SagA

FSIATGSGNSQGGSGSYTPGKC

SEQ ID NO: 127 polynucleotide sequence comprising fusion construct 117-40a-RR

ATGGCCTTTAACAACAAGCCAGAGTGTCTAGTGCACAAGTTTATAGCAATGAAGGGTATCACCAGCATTGAC
 TGATGAAAAATCACACCTGCAATATAGTAAAGACAACGCACAACCTTCAATTGAGAAATATCCTTGACGGCT
 ACCAAAATGACCTAGGGAGACACTACTCTAGCTATTATTACTACAACCTAAGAACCGTTATGGGACTATCA
 AGTGAGCAAGACATTGAAAAACACTATGAAGAGCTTAAGAACAAGTTACATGATATGTACAATCATTATGc
 tagcgggtggcggatccATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAA
 CGAAGGCGAGTAATACTCACGACGATAGTTTACCAAACAGAAACAATTCAGAGGCAAGGCAACTATT
 GATGCAGTTGAAAAAAGTCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAAAC
 TACTGCTGAAATCAACCACTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAA
 TTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTA
 ACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGACTGCATTGTCAGAACA
 AAAAGCTAGCATTTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGCTCTGAACAAA
 ATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGAT
 AATACAAAAGCATTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAA
 AAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAGAGGCAGAACTTAGTCGTC
 TTAAATCCTCAGCTCCGTCTACTCAAGATAGCATTTGTGGGTAAATAATACCATGAAAGCACCGCAAGGCTAT
 CCTCTTGAAAGAACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAA
 AGAGCATGCAGATCAAATTTATGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCCAG
 CAGATCGTAATCGCTTTTGTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCA
 GCTCACATGATTAATAGTGTAAGTCAATTAGGCTTACCACCAGTTACTGTTACAGCAGGATCACAAGA
 ATTTGCAAGATTACTTAGTACCAGCTATAAGAAAAGCTCATGGTAATACAAGACCATCATTTGTCTACGGAC
 AGCCAGGGGTATCAGGGCATTATGGTGTGGGCTCATGATAAACTATTTATTGAAGACTCTGCCGGAGCG
 TCAGGGCTCATTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACTGTGAA
 TGGTATTAAACGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACAT
 ACGGCCATGCTATTAACTTTTTACGTGTAGATAAACATAACCCTAATGC GCCTGTTTACCTTGGATTTTCA
 ACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACG
 CTTTAATAAGACCCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCC CAAAGAGTAGGCACTGTATCTG
 ATACTATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGGCTATTTCATCAAGAAGCT
 GATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGA
 CAGCTTAAATCTCCAAGTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTA
 AAGCAAAACAAGCACAACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCA
 CTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGCAGCCAGAGTGACAGCACTGGTGGCTAAAAAGCTCA
 TTTGCAATATCTAAGGGACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATA
 CTAAGCAAGATTGCTGCTAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCT
 AAACAAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAACCTTAGCTAA
 CGAAAAGGAATATCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTCTTA

SEQUENCE LISTING

CGGGCGTAAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAGAAACG
 AAACAACCTATTAGAAGCTTCAGCAAGATTAGCTGCTGAA AATACAAGTCTTGTAGCAGAAGCGCTTGTTGG
 CCAAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCAT
 CTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAA
 cGtgcgggccgcactcgagCACACCACCACCACCAC

SEQ ID NO: 128 amino acid sequence comprising fusion construct 117-40a-RR

M A F N T S Q S V S A Q V Y S N E G Y H Q H L T D E K S H L Q Y S K D N
 A Q L Q L R N I L D G Y Q N D L G R H Y S S Y Y Y Y N L R T V M G L S S
 E Q D I E K H Y E E L K N K L H D M Y N H Y A S G G G S M S V G V S H Q
 V K A D D R A S G E T K A S N T H D D S L P K P E T I Q E A K A T I D A
 V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H L K E Q Q D N E
 Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E H Q R E L T A T
 E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E T T R A Q D L V
 E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q T A N D N T K A
 L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A A Q K A A L A E
 K E A E L S R L K S S A P S T Q D S I V G N N T M K A P Q G Y P L E E L
 K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K A S P G N Q L N
 Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A Q F A A H M I N S
 V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y K K T H G N T R P
 S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A G A S G L I R N D
 D N M Y E N I G A F N D V H T V N G I K R G I Y D S I K Y M L F T D H L
 H G N T Y G H A I N F L R V D K H N P N A P V Y L G F S T S N V G S L N
 E H F V M F P E S N I A N H Q R F N K T P I K A V G S T K D Y A Q R V G
 T V S D T I A A I K G K V S S L E N R L S A I H Q E A D I M A A Q A K V
 S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T K G S L R T E L L
 A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L H Q T E A L A E Q
 A A A R V T A L V A K K A H L Q Y L R D F K L N P N R L Q V I R E R I D
 N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q S S L E A T I A T
 T E H Q L T L L K T L A N E K E Y R H L D E D I A T V P D L Q V A P P L
 T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L L E A S A R L A A
 E N T S L V A E A L V G Q T S E M V A S N A I V S K I T S S I T Q P S S
 K T S Y G S G S S T T S N L I S D V D E S T Q R A A A L E H H H H H

SEQ ID NO: 129 amino acid sequence comprising a linker in the 117-40a-RR construct

YASGGGS

SEQ ID NO: 130 polynucleotide sequence comprising 40a-RR-117 fusion construct

ATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATAC
 TCACGACGATAGTTTACCAAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAAA
 CTCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAACTACTGCTGAAATCAAC
 CACTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCT
 TGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAG
 AGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGAGCTGCATTGTCAGAACAAAAAGCTAGCATTTC
 GCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGCTCTGAACAAAATATTGCTAAGCTCAA
 TGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTA
 GCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAAAAAGCAATTGACTGAA
 GAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTCAGCTCC
 GTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAAGCACCAGGCTATCCTCTTGAAGAACTTA
 AAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGATCAA
 ATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCAGCAGATCGTAATCGCTT
 TGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATA
 GTGTAcGtGtCAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATTACTT
 AGTACCAGCTATAAGAAAACATCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTATCAGG
 GCATTATGGTGTGGGCTCATGATAAACTATTATTGAAAGACTCTGCCGGAGCGTCAGGGCTCATTCGAA
 ATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACTGTGAATGGTATTAAACGTGGT

SEQUENCE LISTING

ATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTATTAA
 CTTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGAT
 CTTTGAATGAACACTTTTGTAAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGACCCCT
 ATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGCAGCGAT
 CAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTCATCAAGAAGCTGATATTATGGCAGCCC
 AAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAA
 GTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACAAGCACA
 ACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACAGAAG
 CCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACTGGTGGCTAAAAAGCTCATTTGCAATATCTAAGG
 GACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATTTGGC
 TAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGTCTAG
 AAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAACCTTAGCTAACGAAAAGGAATATCGC
 CACTTAGACGAAGATATAGCTACTGTGCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAACCGCT
 ATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAATGGTTAAAGAAACGAAACAACACTATTAGAAG
 CTTAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGAAATG
 GTAGCAAGTAATGCCATTGTGTCTAAATCACA TCTTCGATTACTCAGCCCTCATCTAAGACATCTTATGG
 CTCAGGATCTTCTACAACGAGCAATCTCATTTC TGATGTTGATGAAAGTACTCAACG **gctagcggcggcgg**
gattccATGGCCTTTAACACAAGCCAGAGTGTCAGTGCACAAGTTTATAGCAATGAAGGGTATCACCAGCAT
 TTGACTGATGAAAAATCACACCTGCAATATAGTAAAGACAACGCACAACCTTCAATTGAGAAATATCCTTGA
 CGGCTACCAAAATGACCTAGGGAGACACTACTCTAGCTATTATTACTACAACCTAAGAACCGTTATGGGAC
 TATCAAGTGAGCAAGACATTGAAAAACACTATGAAGAGCTTAAGAACAAGTTACATGATATGTACAATCAT
 TATgcgggccgcactcgagCACCACCACCACCACCAC

SEQ ID NO: 131 amino acid sequence comprising the 40a-RR-117 fusion construct

M S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q
 E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H
 L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E
 H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E
 T T R A Q D L V E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q
 T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A
 A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A P
 Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K
 A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A Q
 F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y K
 K T H G N T R P S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A G
 A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S I K
 Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G F S
 T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G S T
 K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E A D
 I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T K
 G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L H
 Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N R L
 Q V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q S
 S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T V P
 D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L L
 E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K I T
 S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R **A S G G**
G S M A F N T S Q S V S A Q V Y S N E G Y H Q H L T D E K S H L Q Y S K
 D N A Q L Q L R N I L D G Y Q N D L G R H Y S S Y Y Y Y N L R T V M G L
 S S E Q D I E K H Y E E L K N K L H D M Y N H Y A A A L E H H H H H

SEQ ID NO: 132 polynucleotide sequence comprising fusion construct GAS 117 - 40a

ATGGCCTTTAACACAAGCCAGAGTGTGAGTGCACAAGTTTATAGCAATGAAGGGTATCACCAGCATTGAC
 TGATGAAAAATCACACCTGCAATATAGTAAAGACAACGCACAACCTTCAATTGAGAAATATCCTTGACGGCT
 ACCAAAATGACCTAGGGAGACACTACTCTAGCTATTATTACTACAACCTAAGAAC **G**TTATGGGACTATCA
 AGTGAGCAAGACATTGAAAAACACTATGAAGAGCTTAAGAACAAGTTACATGATATGTACAATCATTATGC

SEQUENCE LISTING

ATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAA
 CGAAGGCGAGTAATACTCACGACGATAGTTTACCAAACAGAGAAACAATTCAAGAGGCAAAGGCAACTATT
 GATGCAGTTGAAAAAAGTCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAAAC
 TACTGCTGAAATCAACCACATAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAA
 TTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTA
 ACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTCAGAACAA
 AAAAGCTAGCATTTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAAACGTCTGAACAAA
 ATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGAT
 AATACAAAAGCATTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAA
 AAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTC
 TTAAATCCTCAGCTCCGTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTAT
 CCTCTTGAAGAACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAA
 AGAGCATGCAGATCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCCAG
 CAGATCGTAATCGCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGGCTAGCGCAGTTTGCA
 GCTCACATGATTAATAGTGTAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAGA
 ATTTGCAAGATTACTTAGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATCATTTGTCTACGGAC
 AGCCAGGGGTATCAGGGCATTAATGGTGTGGGCCCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCG
 TCAGGGCTCATTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACTGTGAA
 TGGTATTAAACGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACAT
 ACGGCCATGCTATTAACCTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGATTTTCA
 ACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACG
 CTTTAATAAGACCCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTG
 ATACTATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTCATCAAGAAGCT
 GATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGA
 CAGCTTAAATCTCCAAGTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTA
 AAGCAAAACAAGCACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCA
 CTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGCAGCCAGAGTGACAGCACTGGTGGCTAAAAAAGCTCA
 TTTGCAATATCTAAGGGACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATA
 CTAAGCAAGATTTGGCTAAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCT
 AAACAAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAACCTTAGCTAA
 CGAAAAGGAATATCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTCTTA
 CGGGCGTAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAGAAACG
 AAACAACCTATTAGAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTTGG
 CCAAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGTCTAAATCACATCTTCGATTACTCAGCCCTCAT
 CTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAA
 cGtgcgccgcactcgagCACCACCACCACCACCAC

SEQ ID NO: 133 amino acid sequence comprising fusion construct GAS 117-40a

M A F N T S Q S V S A Q V Y S N E G Y H Q H L T D E K S H L Q Y S K D N
 A Q L Q L R N I L D G Y Q N D L G R H Y S S Y Y Y Y N L R T V M G L S S
 E Q D I E K H Y E E L K N K L H D M Y N H Y A S G G G S M S V G V S H Q
 V K A D D R A S G E T K A S N T H D D S L P K P E T I Q E A K A T I D A
 V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H L K E Q Q D N E
 Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E H Q R E L T A T
 E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E T T R A Q D L V
 E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q T A N D N T K A
 L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A A Q K A A L A E
 K E A E L S R L K S S A P S T Q D S I V G N N T M K A P Q G Y P L E E L
 K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K A S P G N Q L N
 Q Y Q D I P A D R N R F V D P D N L T P E V Q N G L A Q F A A H M I N S
 V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y K K T H G N T R P
 S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A G A S G L I R N D
 D N M Y E N I G A F N D V H T V N G I K R G I Y D S I K Y M L F T D H L
 H G N T Y G H A I N F L R V D K H N P N A P V Y L G F S T S N V G S L N
 E H F V M F P E S N I A N H Q R F N K T P I K A V G S T K D Y A Q R V G
 T V S D T I A A I K G K V S S L E N R L S A I H Q E A D I M A A Q A K V

SEQUENCE LISTING

S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T K G S L R T E L L
 A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L H Q T E A L A E Q
 A A A R V T A L V A K K A H L Q Y L R D F K L N P N R L Q V I R E R I D
 N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q S S L E A T I A T
 T E H Q L T L L K T L A N E K E Y R H L D E D I A T V P D L Q V A P P L
 T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L L E A S A R L A A
 E N T S L V A E A L V G Q T S E M V A S N A I V S K I T S S I T Q P S S
 K T S Y G S G S S T T S N L I S D V D E S T Q R A A A L E H H H H H

SEQ ID NO: 134 polynucleotide sequence comprising fusion construct GAS 117-40N

ATGGCCTTTAACACAAGCCAGAGTGTGAGTGCACAAGTTTATAGCAATGAAGGGTATCACCAGCATTGAC
 TGATGAAAAATCACACCTGCAATATAGTAAAGACAACGCACAACCTTCAATTGAGAAATATCCTTGACGGCT
 ACCAAAATGACCTAGGGAGACACTACTCTAGCTATTATTACTACAACCTAAGAACCGTTATGGGACTATCA
 AGTGAGCAAGACATTGAAAAACACTATGAAGAGCTTAAAGAACAAGTTACATGATATGTACAATCATTATG
taacgggtggcggatccATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAA
 CGAAGGCGAGTAATACTCACGACGATAGTTTACCAAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATT
 GATGCAGTTGAAAAA ACTCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAAAC
 TACTGCTGAAATCAACCCTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAA
 TTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTA
 ACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGAGCTGCATTGTCAGAACAA
 AAAAGCTAGCATTTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGCTCTGAACAAA
 ATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGAT
 AATACAAAAGCATTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAA
 AAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTC
 TTAAATCCTCAGCTCCGTCTACTCAAGATAGCATTTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTAT
 CCTCTTGAAGAACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAA
 AGAGCATGCAGATCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGcgggccgcac
 tcgagCACCAACCACCACCAC

SEQ ID NO: 135

M A F N T S Q S V S A Q V Y S N E G Y H Q H L T D E K S H L Q Y S K D N
 A Q L Q L R N I L D G Y Q N D L G R H Y S S Y Y Y Y N L R T V M G L S S
 E Q D I E K H Y E E L K N K L H D M Y N H Y A S G G G S M S V G V S H Q
 V K A D D R A S G E T K A S N T H D D S L P K P E T I Q E A K A T I D A
 V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H L K E Q Q D N E
 Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E H Q R E L T A T
 E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E T T R A Q D L V
 E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q T A N D N T K A
 L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A A Q K A A L A E
 K E A E L S R L K S S A P S T Q D S I V G N N T M K A P Q G Y P L E E L
 K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K A S P G N Q L N
 Q Y Q A A A L E H H H H H H

SEQ ID NO: 136

AGTTGGTA